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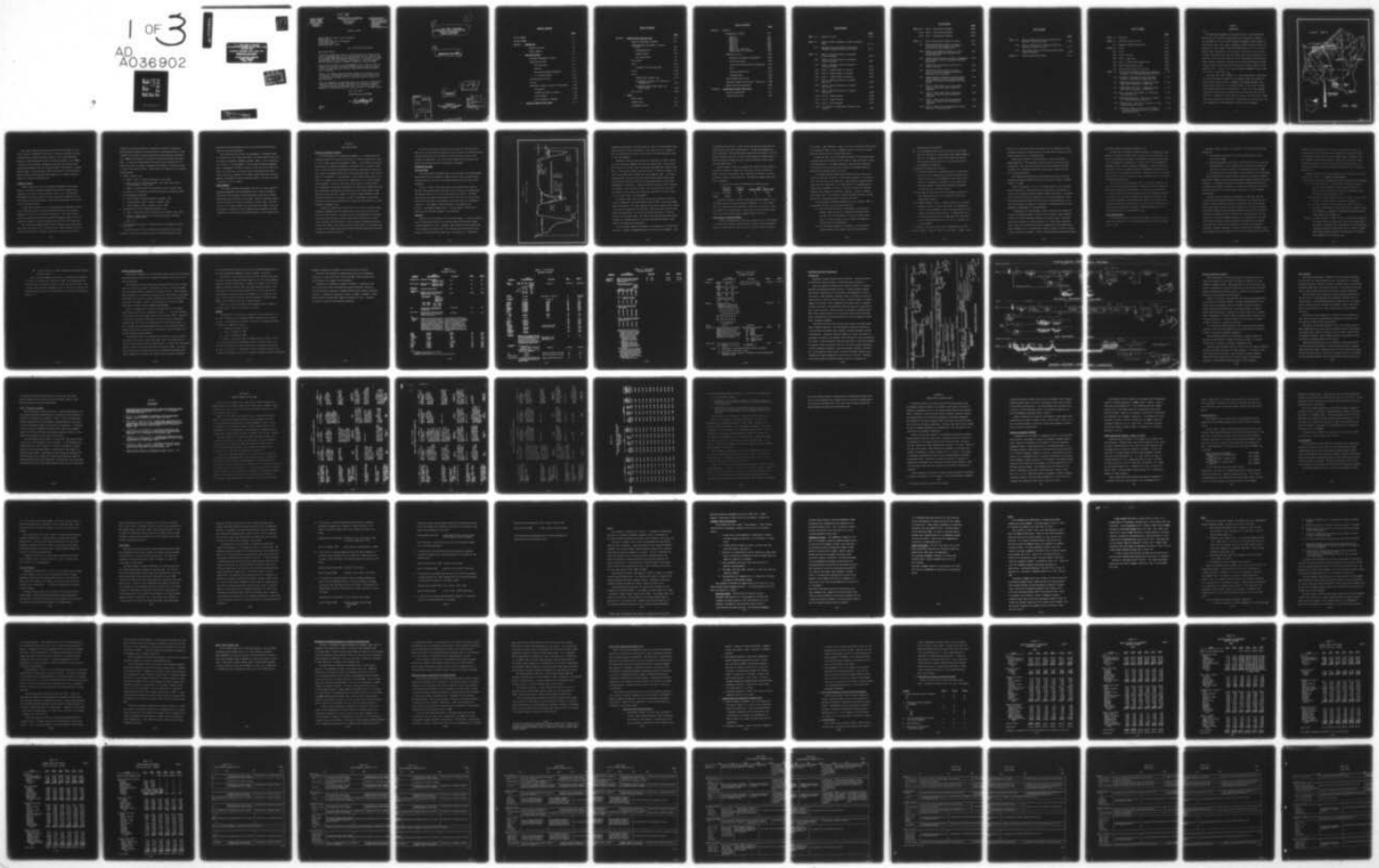

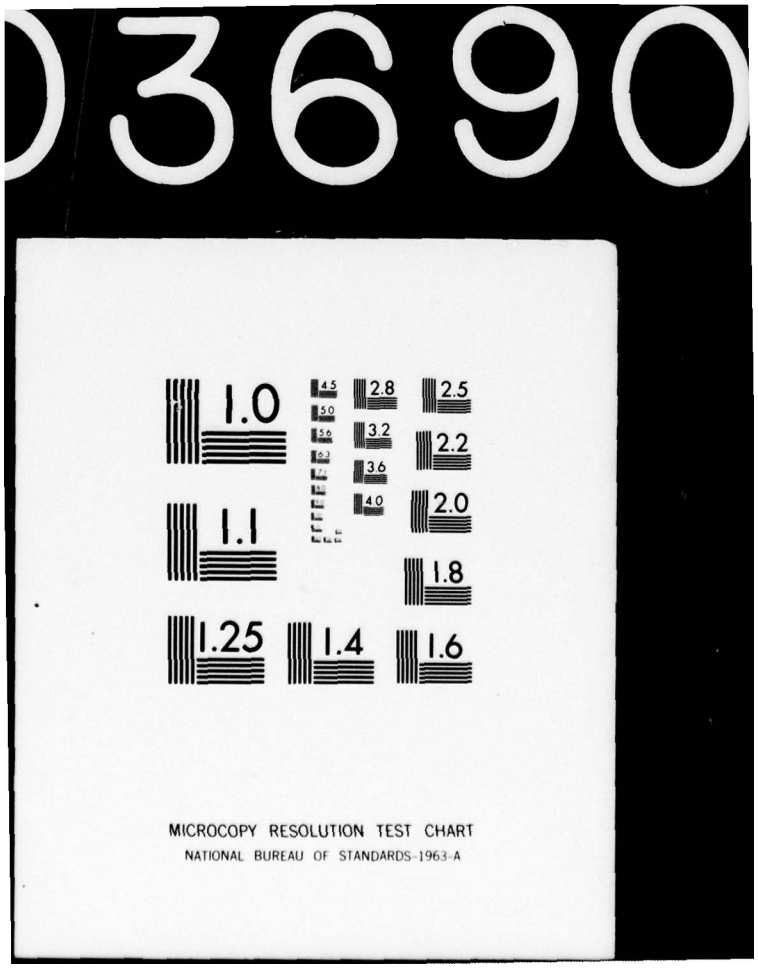
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U. S. ARMY CORPS OF ENGINEERS
CLEVELAND-AKRON METROPOLITAN AND THREE RIVERS
WATERSHED AREA

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY

FORMULATION FINAL REPORT

WRIGHT-McLAUGHLIN ENGINEERS
DENVER, COLORADO
MARCH, 1973

410093

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OTHER WATER-ORIENTED PROJECTS

March 31, 1973

Colonel Robert L. Moore, District Engineer
Buffalo District
United States Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Re: Formulation Final Report

Dear Colonel Moore:

Please find attached four copies of the Formulation Final Report and two sets of replacement pages for the two copies sent earlier. Similar sets of replacement pages have been forwarded directly to the Center for Urban Regionalism and to Linton, Mields, and Coston, Inc. One copy of the report has been sent directly to Havens and Emerson, Ltd. and to AWARE.

Section V of the report will be supplemented within a week by a table of present worth costs for individual treatment plants in each plan and by a series of cost studies to highlight significant patterns and comparisons in the costs.

Figures in the present report have been reduced and reproduced by blueline process. The original plates will be sent to you for final printing and for color reproduction of the three plan layouts, Figures IV-1, IV-2, and IV-4.

Plan C is represented in the present report by a one-color, reduced-scale composite of the four overlays. We have not yet received the overlays for Plans A and B, but we anticipate that we will be able to forward composites for these plans similar to that for Plan C in the near future.

Very truly yours,

WRIGHT-McLAUGHLIN ENGINEERS

By Kenneth R. Wright
Kenneth R. Wright

KRW/eg
Enc.

(1)

(6)

U. S. ARMY CORPS OF ENGINEERS
CLEVELAND-AKRON THREE RIVERS WATERSHED
WASTEWATER MANAGEMENT
SURVEY SCOPE STUDY.

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FORMULATION FINAL REPORT.

(12) 199p.

(11) MARCH 1973

PREPARED BY
WRIGHT-McLAUGHLIN ENGINEERS
DENVER COLORADO

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SECTION I

INTRODUCTION

The Wastewater Management Survey Scope Study for the Cleveland-Akron Metropolitan and Three Rivers Watershed Area was undertaken to identify and recommend one or more regional wastewater management systems capable of achieving the water quality goal intended by the Water Pollution Control Act Amendments of 1972, commonly termed the "Clean Water Bill." This national goal has been interpreted in a set of specific effluent criteria to be met by 1985. The present study shows the national goal and the proposed date of compliance to be a feasible objective for the Study Area with present wastewater treatment technology. The results of the Cleveland Area Survey Scope Study will help to define the various regional and national impacts of the Clean Water Bill. Section II discusses wastewater management systems, goals and criteria in more detail.

The Study Area, shown in Figure I-1, covers approximately 1,500 square miles along the Lake Erie shoreline in northeastern Ohio and includes all or a portion of eight counties: Cuyahoga, Lake, Geauga, Portage, Stark, Summit, Medina and Lorain. Its southern boundary is the natural drainage divide between Lake Erie and the Ohio River. Three rivers, the Cuyahoga, the Chagrin, and the Rocky, originate within the Study Area and flow into Lake Erie. In addition to these three river basins, the Study Area includes land along the Lake Erie shoreline which drains directly into the lake. The present population of the Study Area is about 2.3 million people.

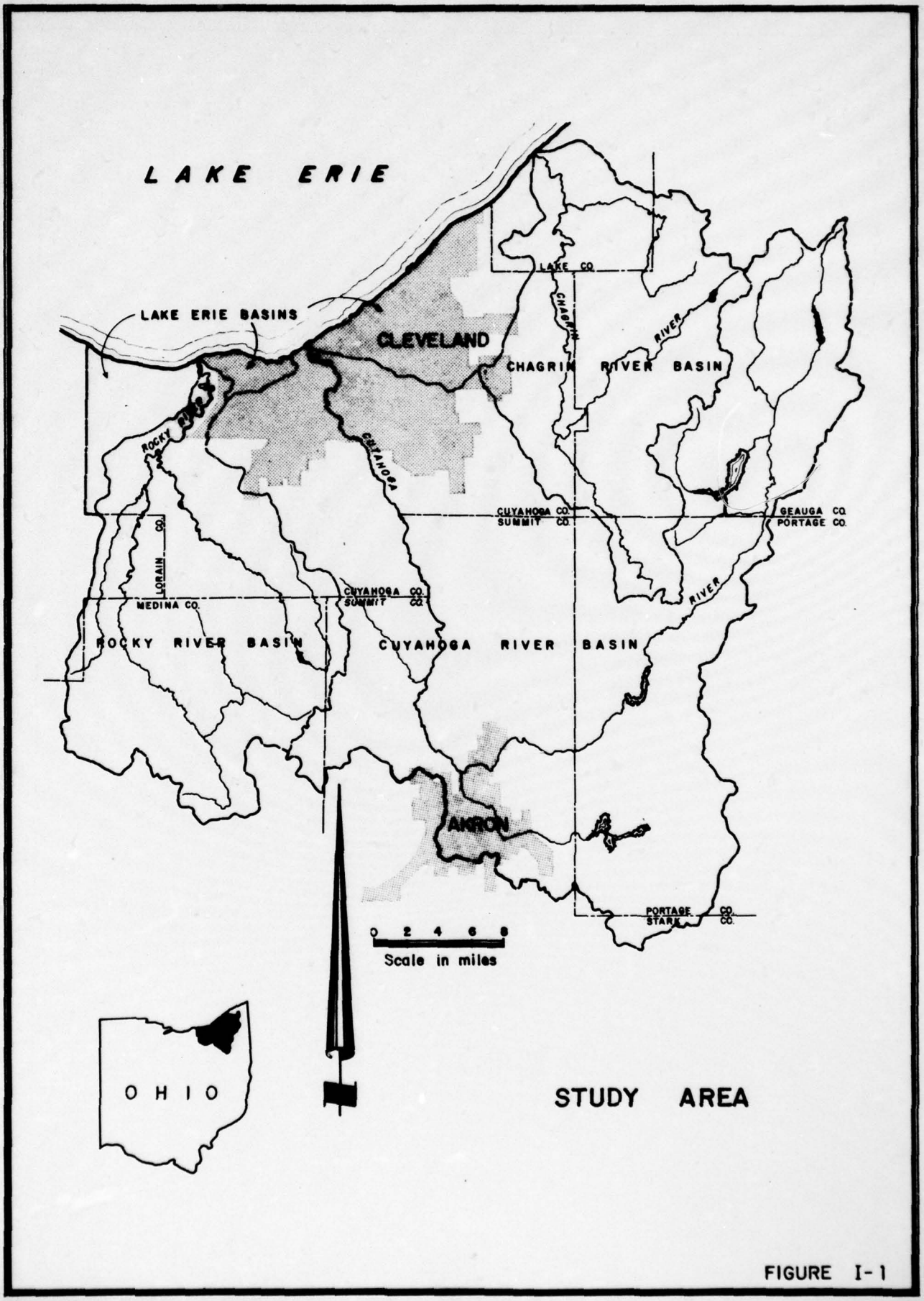

LAKE ERIE
LAKE ERIE BASINS
CLEVELAND
LAKE CO.
CHAGRIN RIVER
CHAGRIN RIVER BASIN
ROCKY RIVER
CUYAHOGA
CUYAHOGA CO.
SUMMIT CO.
GEAUGA CO.
PORTAGE CO.
LORAIN CO.
MEDINA CO.
CUYAHOGA CO.
SUMMIT CO.
CUYAHOGA RIVER
ROCKY RIVER BASIN
CUYAHOGA RIVER BASIN
AKRON
PORTAGE CO.
STARK CO.
0 2 4 6 8
Scale in miles
OHIO
STUDY AREA

FIGURE I-1

This report combines and presents the results of the Phase III portion of the plan formulation effort, and is based upon the Phase III Technical Appendices prepared by Havens & Emerson, Ltd., Wright-McLaughlin Engineers, and Associated Water and Air Resources Engineers, Inc. (AWARE). It presents three wastewater management plans, which have been selected, optimized and phased to meet the projected needs in the Study Area through the year 2020. It also describes "early-action work" for each plan, which would initiate the plan and provide an opportunity to gather field test data and to construct prototype units.

SUPPORTING STUDIES

Closely related to this entire Wastewater Management Survey Scope Study is the recently completed Northeast Ohio Water Development Plan, prepared for the State of Ohio by Burgess & Niple, Ltd. The Northeast Ohio (NEO) Plan provided significant basic data and an integration of current planning and design concepts in water quality management for this portion of the State of Ohio.

In 1971 Havens & Emerson, Ltd., of Cleveland, Ohio, undertook a feasibility study and prepared a report entitled "Alternatives for Managing Wastewater" for the U. S. Army Corps of Engineers. This report further refined and documented basic data, wastewater management opportunities and advanced wastewater treatment technology specifically for the Study Area.

The current Cleveland-Akron/Three Rivers Watershed Survey Scope Study was divided into three areas of responsibility: Havens & Emerson, Ltd. defined the rates of flow of domestic wastewater and storm runoff for the

Study Area and prepared studies on water-based treatment of wastewater; Wright-McLaughlin Engineers performed research and developed plans for land treatment of wastewater; and Associated Water and Air Resources Engineers, Inc., (AWARE) investigated the treatment of specifically industrial wastewater. In addition, Wright-McLaughlin Engineers held responsibility for formulating overall wastewater management plans based on the data developed in these three technical fields. These efforts are summarized in the reports tabulated below.

1. Havens & Emerson, Ltd.
   a. Phase I, Part A, "Municipal Wastewater", May, 1972.
   b. Phase I, Part B, "Stormwater Runoff", May, 1972, and "Ten-Year Storm Supplement", June, 1972.
   c. Phase II, "Systems Design and Estimates of Cost", October, 1972.
   d. Phase III, "Time Phasing of Selected Alternatives", February, 1973.
2. Wright-McLaughlin Engineers
   a. "Land Treatment Technical Appendix", November, 1972.
   b. "Land Treatment, Phase II Report", December, 1972.
   c. "Land Treatment, Phase III Report", April, 1973.
3. Associated Water and Air Resources Engineers, Inc.
   a. Phase I, "Data Acquisition and Definition of Problem", May, 1972.
   b. Phase II, "Design and Cost of Industrial Wastewater Treatment Systems", October 1972.
   c. Phase III.
4. Wright-McLaughlin Engineers, "Formulation Technical Appendix", November, 1972.

During the course of the Survey Scope Study, parallel work was performed by the Kent State University Center for Urban Regionalism, which

provided an on-going evaluation of all of the technical and scientific studies as they were developed.

The formulation work involved the development of conceptual plans, the integration of the studies performed in the three project fields, and the layout of wastewater management systems. Phase I of the formulation work resulted in the development of nine regional wastewater management plans. Subsequently the Phase II portion of the work carried these nine plans, plus three more, to a higher level of optimization and detail. These twelve plans, presented in the above-listed "Formulation Technical Appendix, Development of Twelve Alternative Plans", are briefly reviewed in Section III of this report.

REPORT EMPHASIS

This report describes and evaluates the costs of three alternative wastewater management plans designated as Plan A, Plan B, and Plan C. These three final alternatives were based upon a selection of features and concepts from the twelve initial plans. Section IV presents Plans A, B and C, and Section V contains an analysis of their costs. The final section of this report compares the three plans with respect to resource requirements, reliability of major components and processes, and other considerations which may not be reflected clearly in the financial costs.

SECTION II

GOALS AND CRITERIA

WASTEWATER MANAGEMENT PLANNING

The primary objective of wastewater management is to create social and ecological benefits by protecting the quality of receiving water bodies such as rivers, lakes, oceans and groundwater systems. To be successful, planning and programs for wastewater management must operate within a regional framework, so that goals may be established and efforts coordinated to control all the sources of wastewater which affect a particular water body. Thus the concepts of a "watershed", a "drainage basin", and of water sources being "tributary" to a common river or lake play an important part in a study of wastewater management. Similarly, when water quality goals are established for all the geographic areas whose wastewaters are tributary to a common receiving body, appropriate consideration must be given to the various types of water pollution within each area. Domestic or sanitary sewage (sometimes termed municipal wastewater in this report), industrial wastewater, and polluted urban storm runoff are the three sources of water pollution dealt with in this wastewater management study.

In addition to goals defined specifically for a natural drainage system, wastewater management goals are established for political entities on both local and national levels. The planning effort represented by the Cleveland Area Survey Scope Study was directed toward achieving three sets of goals: state, national, and international; as well as toward coordination with particular local agencies and studies related to water quality in the Study Area. Included in this latter group are the Three Rivers Watershed District and the Cuyahoga River Restoration Study.

In order for the Survey Scope Study to proceed, the various sets of goals had to be translated into specific sets of criteria for effluent quality, and the successively more stringent criteria had to be set into a time schedule for compliance. The criteria and scheduling are defined at the end of this section following a discussion of the goals.

BACKGROUND AND GOALS

The Great Lakes

The United States and Canada share a vital interest in the Great Lakes. Approximately 30 million people in 1966 lived on or near the Great Lakes, representing one out of every eight Americans and one out of every three Canadians.

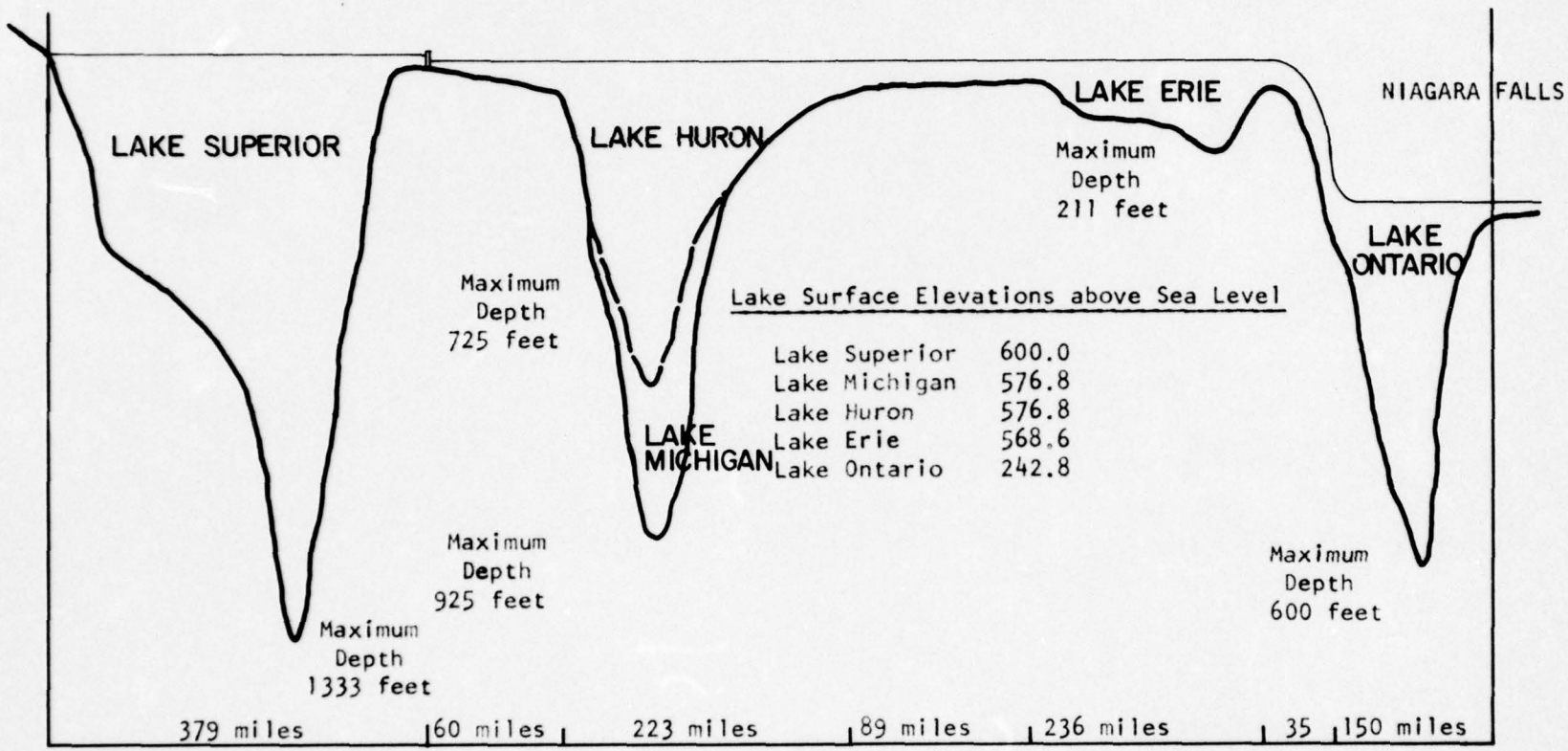
The U. S. waters of the Great Lakes are contained by the states of New York, Pennsylvania, Ohio, Michigan, Illinois, Wisconsin and Minnesota. The Canadian waters all lie within the Province of Ontario. The Great Lakes contain the second largest quantity of fresh water in the world and are the source of water for hundreds of cities and towns and thousands of industries. They support fishing industries and commerce, and provide recreational opportunities. The importance of these lakes is keenly felt by millions of people in two countries.

Lake Erie

Lake Erie is the smallest of the five Great Lakes. It covers a surface area of 9,900 square miles with an average depth of 58 feet and reaches a maximum depth of 211 feet. Together, these dimensions provide Lake Erie with a volume of 110 cubic miles, less than one third the volume of Lake Ontario, the second smallest Great Lake. See Figure II-1. Lake Erie's

FIGURE II-1

PROFILE OF THE GREAT LAKES



Lake Surface Elevations above Sea Level

Lake Superior	600.0
Lake Michigan	576.8
Lake Huron	576.8
Lake Erie	568.6
Lake Ontario	242.8

immediate drainage basin (including Lake St. Clair) is 29,700 square miles. Seventy percent of this drainage basin lies within the U. S. Erosion of the silt and clay bluffs which surround much of the lake accounts for most of the lake sediment.

The Detroit River provides 90 percent of Lake Erie's inflow, amounting to an average of 188,000 cubic feet per second (cfs). The total normal inflow for a two and a half year period would equal the volume of Lake Erie. If all of the influent water were clean, it would not, however, result in the lake's being flushed after this length of time. It has been estimated that, due to currents and stratification, approximately seven and a half years would be required to displace 90 percent of the stable contaminants in Lake Erie. Lake Erie undergoes a yearly cycle of heating and cooling. From the middle of March until the end of July the waters are warmed by the sun and wind. During the remainder of the year, there is a net loss of heat to the atmosphere.

The warmer, upper layer of water, called the epilimnion, varies annually in temperature from approximately 0.5°C to 24°C. During the summer months the warmth of this water produces a decrease in density which results in an effective separation from the deep, colder and heavier zone of water called the hypolimnion. As long as the thermocline exists, it acts as a barrier to vertical mixing. This means that dissolved pollutants may be retained for prolonged periods in the epilimnion and that oxygen is prevented from reaching the hypolimnion.

As the surface temperature decreases, the thermocline is forced lower and lower, eventually disappearing about the first week of December. This

is termed the fall overturn. Later, the spring overturn occurs when the surface waters reach their maximum density. During these seasonal overturns, pollutants in the epilimnion and hypolimnion are subject to vertical mixing. Shallower portions of a lake, such as Lake Erie's Western Basin, experience almost constant pollution dispersion because of nearly equal vertical temperatures.[1, 2]

Lake Erie water is used for municipal and industrial water supplies, recreation, navigation, commercial fishing and a variety of other purposes. The daily withdrawal of water indicates the important role Lake Erie plays relative to both countries. The following summary shows daily water withdrawals.

Municipal and Industrial Withdrawals of Lake Erie Water

	Population Served	Municipal MGD	Industrial Process, MGD	Industrial Cooling MGD
U. S. A.	3,330,000	634	112	4,491
Canada	87,000	24	4	18

Lake Erie continues to provide the United States and Canada with an invaluable resource for both business and pleasure. It is only logical that this resource should be protected. Lake Erie, in particular, being the smallest of the Great Lakes, is more sensitive and thus more responsive to the pollutional pressures caused by man's activities.

United States - Canada Agreements

In 1909 the Boundary Waters Treaty was signed by the U. S. and Canada. It provided that "boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property

on the other." Most important, however, the treaty created the International Joint Commission (IJC) to study, recommend, and give direction in matters concerning the pollution of international waters.

Through the years, the IJC has answered requests from both governments to examine pollution problems resulting from new types and greater volumes of discharged wastes. Increased population concentrations, developing industries and even the occurrence of epidemics has prompted physical, bacterial and chemical studies by the IJC.

In the 1950 IJC Report, Water Quality Objectives were specified to restore and maintain the waters in the connecting channels in a condition which would not impair their many uses. Both Governments approved these objectives, which make explicit the requirements of the Boundary Waters Treaty and are supported in whole or in part by the pollution abatement programs of the respective enforcement agencies. Success in reducing pollutional loads in the connecting channels has been achieved, although growth has in some cases exceeded treatment efficiency.

The United States and Canada requested the IJC in October, 1964, to investigate and report on the following questions:

(1) "Are the waters of Lake Erie, Lake Ontario, and the International section of the St. Lawrence River being polluted on either side of the boundary to an extent which is causing, or is likely to cause, injury to health or property on the other side of the boundary?"

(2) "If the foregoing question is answered in the affirmative, to what extent, by what causes, and in what localities is

such pollution taking place?"

(3) "If the Commission should find that pollution of the character just referred to is taking place, what remedial measures would, in its judgment, be most practicable from the economic, sanitary and other points of view and what would be the probable cost thereof?"

The Commission reported the following:

(1) The waters of Lake Erie, Lake Ontario and the international section of the St. Lawrence River are being seriously polluted by both the U. S. and Canada to the detriment of both countries. Contaminants originating in one country move across the boundary (transboundary movement) and degrade the water quality of the other country.

(2) Municipalities and industries are the major polluters and cause lakewide effects in all jurisdictions which share these boundary waters.

(3) Remedial measures include: immediate reduction in detergent phosphorus content, municipal and industrial treatment facilities to reduce phosphorus input to the watercourses and continuous surveillance and monitoring. In 1968 dollars the required municipal and industrial wastewater facilities would cost an estimated $1,373 million for the U. S. and $211 million for Canada.

In addition, there were sixteen other recommendations set forth in the IJC's report. (The IJC issued its final report in 1970). Later,

governors of states and premiers of provinces met and supported a formal agreement between the two countries with the IJC reports forming the major technical guidelines for the negotiations.

Project Hypo, (1970), studied the causes, effects and extent of oxygen depletion in the hypolimnion (bottom water) of the Central Basin of Lake Erie. The study indicated that controlling phosphate addition to Lake Erie is immediately required to attain quick recovery and prevent irreversible effects.

The International Agreement on Great Lakes Water Quality was developed and signed by President Nixon and Prime Minister Trudeau in Ottawa, on April 15, 1972.

Under this Agreement, the U. S. and Canada agreed to a set of water quality objectives in common waters and a committment to one another to carry out the necessary measures needed to obtain these goals. The Agreement also gives the IJC the responsibility to oversee guidelines, verify data submitted by governments and industries, and when necessary, to report to the public on progress or hindrances in implementing terms of the Agreement, independently of the governments.

In compliance with the Agreement, specific water quality objectives are set for dissolved oxygen, total and fecal coliforms, total dissolved solids, pH, iron and phosphate loadings to the lake system. Additional objectives concerned with floating debris, oil, those factors affecting odor, taste, color and growth of aquatic organisms were also agreed upon. Other parameters such as radioactivity, ammonia, arsenic, chloride, cyanide, organic contaminants, phenols, sulfate, heat discharges and some heavy metals

are being studied to determine acceptable limits.

By 1975, every municipality discharging wastes into Lake Erie or Lake Ontario is to have a treatment plant in place or under construction. To control eutrophication, the amount of phosphorus discharged into the lakes is to be reduced by a combination of treatment facilities and detergent phosphate control. Reduced loadings of phosphorus to Lake Erie should be realized in the first two years following the Agreement and should eliminate over half of the present contribution. Programs are also to be implemented which will control industrial waste discharges, pollution from land drainage and dredge spills.

As this brief outline indicates, there is a sincere interest on the part of the United States and Canada to rehabilitate the Great Lakes and particularly Lake Erie and Lake Ontario. The functions of the IJC are to study and report pollutional problems and pollution abatement progress to a public which continues to demand clean, healthy watercourses. The International Agreement on Great Lakes Water Quality now stands as a potent force against pollution and as a tool with which both countries can significantly improve their wastewater treatment performance for the mutual betterment of our transboundary waters.

U. S. National Goals

A broad concensus that the quality of the Nation's waters must be improved found expression in the Federal Water Pollution Control Act Amendments of 1972.

The basic intent of the act is contained in a series of national goals and policies:

1. The discharge of pollutants into the navigable waters will be eliminated by 1985.
2. Wherever attainable, water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water will be achieved by July 1, 1983.
3. The discharge of toxic pollutants in toxic amounts will be prohibited.

This national policy includes federal financial assistance for publicly owned waste treatment works and encourages waste treatment planning on an area-wide basis. It emphasizes the need for research and demonstration efforts to develop the necessary technology to eliminate the discharge of pollutants. Public participation in the fight against pollution is to be encouraged and assisted.

The Water Pollution Control Act Amendments of 1972 state that one or more projects should be undertaken to demonstrate new methods and techniques for the elimination or control of pollution within the watersheds of the Great Lakes, and that the Chief of Engineers is directed to design and develop a demonstration wastewater management program for the rehabilitation and environmental repair of Lake Erie. The program must set forth alternative systems for managing wastewater on a regional basis including land treatment disposal systems with "aerated treatment-spray irrigation technology," provisions for the disposal of solid wastes, and advanced wastewater treatment technology. The new law states that wastewater treatment management should encourage construction of revenue-producing facilities

through the use of sewage effluent recycling to agricultural lands; the storage of pollutants not recycled; the reclamation of wastewater; and an environmentally sound method of handling sewage sludge. Wastewater treatment management should take advantage of opportunities related to sewage treatment and sewage recycling for industrial and municipal wastes, including waste heat and thermal discharges, and open space and recreational possibilities.

The Water Pollution Control Act Amendments of 1972 provide for effluent limitations in Title III - Standards and Enforcement:

" (b) In order to carry out the objective of this act there shall be achieved--

"(1) (A) not later than July 1, 1977, effluent limitations for point sources, other than publicly owned treatment works, which shall require the application of the best practicable control technology currently available...and

"(B) for publicly owned treatment works in existence on July 1, 1977,... effluent limitations based upon secondary treatment...or

"(C) not later than July 1, 1977, any more stringent limitation, including those necessary to meet water quality standards, treatment standards, or schedules of compliance established pursuant to any State law or regulation....

"(2) (A) not later than July 1, 1983, effluent limitations for categories and classes of point sources, other than publicly owned treatment works, which shall require application of the best available technology economically achievable which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants...and

"(B) not later than July 1, 1983, compliance by all publicly owned treatment works..."

There is a clear mandate from Congress to eliminate the discharge of pollutants into the Nation's waterways by 1985. Far-reaching goals and policies relative to pollution control are now the law of the land. This study and report has been undertaken as part of the effort to achieve the established quality goals for the waterways of the Three Rivers Basin and Lake Erie.

EFFLUENT DESIGN CRITERIA

To provide a framework for the Survey Scope Study, the Corps of Engineers established design criteria and a schedule for phasing from one set of criteria to the next.

The alternative regional plans were developed using two sets of design criteria, referred to as Level 1 and Level 2. Level 1 criteria are based upon the proposed effluent standards of the State of Ohio. Those standards allow variations in the effluent concentrations of some indices of pollution as functions of the receiving water classification, dilution availability, plant size, and season. Level 1 criteria consist of the most stringent requirement for each of those effluent concentrations.

Level 2 is based upon the national goal identified in the Federal Water Pollution Control Act Amendments of 1972, ". . . that the discharge of pollutants into the navigable waters be eliminated by 1985." The Office of the Chief of Engineers, Department of the Army (O.C.E.) established technical goals for this study commensurate with that national goal, i.e., (1) to prevent the continued degradation of our water resources by waterbourne wastes and (2) to provide for the efficient reuse of treated or renovated wastewater and by-products.

The technical goals were translated into effluent criteria by O.C.E., consisting of the most stringent constituent levels from among those required for public water supply, irrigation water, livestock water, and aquatic habitat. Those criteria are referred to as the O.C.E. Goals. The O.C.E. Goals should not be interpreted as effluent standards established by the Federal Government, but rather the translation by the Corps of Engineers

of the stated national objective into a set of consistent guidelines for all similar wastewater management studies throughout the nation.

The effluent criteria making up Level 2 differ from the O.C.E. goals to reflect the continuous performance capability of the various advanced wastewater treatment technologies. Although the treatment facilities are capable of meeting the O.C.E. goals more than ninety (90) percent of the time, Level 2 criteria can be met essentially all of the time, barring any unforeseen circumstances having low probability of occurrance. The Level 2 criteria add to the O.C.E. goals the parameter, Chemical Oxygen Demand, with an effluent level not to exceed 10 mg/l.

Table II-1 itemizes the State of Ohio proposed effluent standards, the O.C.E. goals, and Level 1 and Level 2 criteria.

PHASING

The Water Pollution Control Act Amendments of 1972 constituted the principal guidance for the recommended phased implementation of Plans A, B, and C. In conformance with that Act the levels of municipal wastewater treatment are scheduled as follows:

1. Secondary treatment by 1977
2. Level 1 treatment by 1983
3. Level 2 treatment by 1985

In addition, the United States and Canada agreed on 15 April 1972 to limit the concentrations of phosphorus to one milligram per liter from municipal treatment facilities discharging more than one million gallons per day into Lake Erie. In accordance with that agreement, the facilities scheduled for upgrading directly from secondary treatment to Level 2 incorporate

phosphorus removal unit processes in the interim period from 1977.

Collection and treatment of combined sewer overflows are scheduled as early as is practical, and not later than 1980, thereby discontinuing the discharge of raw sewage into the waterways.

Collection and treatment of separate stormwater is scheduled at the time at which the various drainage basins become urbanized. The basins which are presently urbanized, or become urbanized before 1980 are scheduled for Level 1 treatment, and upgrading to Level 2 by 1985 is scheduled. Those basins becoming urbanized after 1980 are scheduled for Level 2 treatment as soon as is practical after becoming urbanized.

TABLE II-1

EFFLUENT CRITERIA

CONSTITUENT	PROPOSED OHIO EFFLUENT STANDARDS	O.C.E. GOALS	LEVEL I	LEVEL II
Settleable Solids	Substantially complete removal: Monthly ave. 0.3 ml/l, Monthly max. 1.0 ml/l	Trace	(1)	(2)
Oils (and grease)	Lowest practical level attainable by today's technology: Monthly ave. 10 mg/l, Monthly max. 20 mg/l	Trace	(1)	(2)
Debris, Scum, Floatables	Substantially complete removal	None	(1)	(2)
Suspended Solids (Inert)	Reduction to such a degree as to not cause noticeable turbidity in the receiving stream, but shall not exceed: Free Flowing Warm Water Fisheries — Monthly Ave. 30 mg/l, Maximum Daily 45 mg/l; Cold Water Fisheries, Pooling Streams, Scenic Rivers, Reservoirs, and Inland Lakes — Monthly Ave. 20 mg/l, Maximum Daily 30 mg/l	2 mg/l	20 mg/l	5 mg/l
Color	Effluent imparts no objectionable color nor increases the background level by 5 standard units	75 Color Units	(1)	(2)
Taste and Odor	Reduction to such a degree as to not cause and objectionable odor, a threshold odor number 725 to potable water supplies, nor cause fish flesh tainting.	Not offensive	(1)	(2)
*Toxic Constituents and Heavy Metals	Reduction of any and all materials to such a degree that the concentration thereof, singly or in combinations, in any discharge is not harmful to human health or aquatic life to such a degree that the concentration thereof in the discharge does not kill 25% of a mixed fish population common to the receiving stream in a 1:1 dilution of the sample with waters of the receiving stream provided that the calculated concentration in the receiving stream does not exceed 1/20 of the 96 hour median tolerance limit.	Critical levels for all constituents not specifically mentioned shall be based upon natural background levels of the receiving watercourse or aquifer with exception of constituents that are highly toxic or injurious to the environment at trace levels. If current State water quality standards are higher, these standards shall apply; or levels of nontoxic constituents may be relaxed upward (above background levels) should they be proven to be not injurious to the environment of the region.		
Arsenic	0.05 mg/l	Absent	(1)	(1,3)
Barium	1.0 mg/l	Absent	(1)	(1,3)
Cadmium	0.01 mg/l	Absent	(1)	(1,3)
Chromium				
hexavalent	0.05 mg/l	Absent	(1)	(1,3)
total	0.30 mg/l	Absent	(1)	(1,3)
Copper	1.0 mg/l	Absent	(1)	(1,3)
Iron				
total	5.0 mg/l	No Comment	(1)	(1,3)
soluble	0.3 mg/l	No Comment	(1)	(1,3)
Lead	0.05 mg/l	Absent	(1)	(1,3)
Mercury	0.005 mg/l	Absent	(1)	(1,3)
Nickel	0.01 mg/l	Absent	(1)	(1,3)
Silver	0.05 mg/l	Absent	(1)	(1,3)
Zinc	5.0 mg/l	Absent	(1)	(1,3)

NOTES:
1 Equivalent to the proposed Ohio effluent standards
2 Equivalent to the O.C.E. goals
3 Subjected to best practical treatment of most concentrated effluent stream

TABLE II-1 (continued)
EFFLUENT CRITERIA

CONSTITUENT	PROPOSED OHIO EFFLUENT STANDARDS			O.C.E. GOALS	LEVEL I	LEVEL II
Ammonia Nitrogen	Stream Class.	April -Oct (mg/l)	Nov- March (mg/l)	Calculated Increase In Stream @ Critical Flow (mg/l)	0.1 mg/l as N	2.0 mg/l as N	<1.0 mg/l as N
	I & II	2.0	4.0	0.10			
	III & IV	10.0	15.0	0.05			
		5.0	10.0	0.10			
		2.5	5.0	0.15			
Organic Nitrogen	No Comment			Total Nitrogen = 10 mg/l as N	(1)	5 mg/l Total Nitrogen
Nitrates and Nitrites	No Comment			4.0 mg/l as N	(1)	(2)
Aluminum	No Comment			1.0 mg/l	(1)	(1,3)
Antimony	No Comment			Absent	(1)	(1,3)
Beryllium	No Comment			Absent	(1)	(1,3)
Boron	No Comment			Absent	(1)	(1,3)
Cobalt	No Comment			Absent	(1)	(1,3)
Molybdenum	No Comment			Absent	(1)	(1,3)
Selenium	No Comment			Absent	(1)	(1,3)
Thallium	No Comment			Absent	(1)	(1,3)
Tin	No Comment			Absent	(1)	(1,3)
Titanium	No Comment			Absent	(1)	(1,3)
Cyanide						
Total	0.2 mg/l			Absent	(1)	(1,3)
Free	0.025 mg/l			Absent	(1)	(1,3)
Phenols	0.3 mg/l			Absent	(1)	(1,3)
Aldrin	0.017 mg/l				(1)	(1,3)
Chlordane	0.003 mg/l				(1)	(1,3)
DDT	0.042 mg/l				(1)	(1,3)
Dieldrin	0.027 mg/l				(1)	(1,3)
Endrin	0.001 mg/l				(1)	(1,3)
Heptachlor	0.018 mg/l				(1)	(1,3)
Heptachlor Epoxide	0.018 mg/l			Pesticides and chlorinated hydrocarbons - absent	(1)	(1,3)
Lindane	0.056 mg/l				(1)	(1,3)
Methoxychlor	0.035 mg/l				(1)	(1,3)
Organic PO_4 Carbonates	0.1 mg/l				(1)	(1,3)
Toxaphene	0.005 mg/l				(1)	(1,3)
Radioactive Materials	Reduction to such a degree that (1) concentrations of unidentified radionuclides in the discharge do not exceed (a) 30 pCi or (b) limiting values specified by the AEC for water in which certain radionuclides are known to be absent; or (2) concentrations of identified radionuclides do not exceed limits specified by AEC.			Alpha Radiation 1 pCi Beta Radiation 100 pCi Gamma Radiation - Trace	(1)	(1,3)
Fecal Coliform Bacteria	May through October: 200/100 ml - monthly geometric mean 400/100 ml - 90% less than, monthly November through April: 1000/100 ml - monthly geometric mean (Based on >10 samples/month)			200/100 ml	200/100 ml	200/100 ml
Virus	No Comment			Inactivated, but present at trace levels	(1)	(2)
Fecal Streptococci	No Comment			Inactivated, but present at trace levels	(1)	(2)
pH and Alkalinity	5 - 9, pH values up to 10 provided the OH^- concentration does not exceed 10 mg/l if the discharge does not violate water quality standards.			Alkalinity 100-130 mg/l when pH is 6-7	(1)	(1)

TABLE 11-1 (continued)
EFFLUENT CRITERIA

CONSTITUENT	PROPOSED OHIO EFFLUENT STANDARDS	O.C.E. GOALS	LEVEL I	LEVEL II
Deoxygenating Wastes (BOD_5 and SS)	Reduction so that DO levels of receiving stream is not depressed below established criteria and in accordance with the following criteria:	BOD_5 2 mg/l SS 2 mg/l	5.0 mg/l 8.0 mg/l	<5.0 mg/l <5.0 mg/l

Class I - Cold Water Fisheries

Effluent Concentrations: BOD_5 - mg/l		SS - mg/l		Calculated Increase In Stream @ Critical Flow
Monthly Average	Maximum Daily	Monthly Average	Maximum Daily	(mg/l)
15	23	18	25	0.3
10	15	12	18	0.4
7	10	10	15	0.5
5	8	8	12	0.6

Class II - Scenic Waters, Streams, Reservoirs, and Lakes

15	23	15	25	0.3
10	15	12	18	0.4
7	10	10	15	0.5
5	8	8	12	0.6

Class III - Free Flowing Warm Water Fisheries (for at least 15 miles below discharge)

30	45	30	45	0.5
25	40	25	40	1.0
20	30	20	30	2.0
15	25	15	25	3.0
10	15	12	18	4.0
7	10	10	15	4.5
5	8	8	12	5.0

Class IV - Pooling Streams, Impoundments, Back Waters and Lakes Classified for Warm Water Fisheries

20	30	20	30	0.5
15	25	15	20	1.0
10	15	12	18	2.0
7	10	10	15	3.0
5	8	8	12	5.0

Exceptions for Class III and IV Waters

(A) In congested, heavily populated and industrial corridors where discharges of a number of identities contribute to single or multiple water quality violations - additional reductions will be required as follows:
  1) Additive effects of multiple discharges shall not exceed requirements of one discharge of the combined wastes at one point, or
  2) Effluent requirements will be determined by river studies w/ appropriate allotment of waste loads provided no discharge exceed requirements for Class III and IV streams.

(B) If slope >10 ft/mile or low flow depth <1.0 ft and free of pooling - allowable incremental increase in BOD_5 is 50%

(C) For isolated communities of 1500 or less and an untreated waste load of < 2000 PE that discharges to a dry weather ditch and for which lagoons are the only practical method of treatment, allowable effluent quality will be:
  BOD_5 = 30 mg/l, SS = 45 mg/l

TABLE II-1 (continued)

EFFLUENT CRITERIA

CONSTITUENT	PROPOSED OHIO EFFLUENT STANDARDS	O.C.E. GOALS	LEVEL I	LEVEL II
Phosphorus	Wastewater Volume (mgd) / Effluent Concentration (mg/l - P) 1975 / 1980 Discharges to: (a) Free Flowing Tributaries to Lake Erie 10+ 1.0 0.5 1-9.9 1.0 1.0 1.0 8.0 1.0 (b) Free Flowing Tributaries of Ohio River 50+ 1.0 0.5 10-49.9 2.0 1.0 1-9.9 8.0 2.0 (c) Lakes, Reservoirs, Significant Impoundments and Pools 1.0+ 2.0 0.5 1.0 8.0 1.0	Entering a Lake: 0.05 mg/l as PO_4 Entering a Flowing Stream: 0.10 mg/l as PO_4	0.5 mg/l as P	<0.5 mg/l as P
Temperature	(A) Warm Water Fisheries Reduction of heat content so that in no case the discharge increase the river temperature by more than 5°F, if below the following formula applies: Allowable Heat Discharge Rate(BTU/sec) = 62.4(River flow, CFS)(T_A - T_R)(90%) T_A = Allowable Maximum River Temp. Month: Jan Feb Mar Apr May Jun T_A: 50 50 60 70 80 90 Month: Jul Aug Sep Oct Nov Dec T_A: 90 90 90 78 70 57 T_R = River Temp. (daily ave.) above discharge		5°F increase	(2)
Turbidity	No Comment	5 Jackson Units	(1)	(2)
Dissolved Solids	Control to such a point that the discharged dissolved solids load does not increase the dissolved solids concentration in the receiving waters by more than 5% on a calculated basis provided that (a) the dissolved solids criterion in the receiving waters is not exceeded, or (b) the dissolved solids concentration in the discharge does not exceed five times the dissolved solids criteria for the receiving water.	500 mg/l w/specific limits established for specific inorganics, CO_2 25 mg/l SO_4^2 10 mg/l Ca 30 mg/l Cl 250 mg/l Na 10 mg/l Mg 125 mg/l Fl 1.7 @ 10°C to 0.8 mg/l @ 30°C. Al 1 mg/l HCO_3 ±50 mg/l variation from ambient conditions Mn 0.5 mg/l	2500 mg/l	(2)
Dissolved Oxygen	Streams classified as warm water fisheries 4.0 mg/l Streams classified as cold water fisheries 6.0 mg/l	No Comment except BOD_5 < effluent DO	6 mg/l	6 mg/l

Notes:
1. Equivalent to the proposed Ohio effluent standards.
2. Equivalent to the O.C.E. goals.
3. Subjected to best practical treatment of most concentrated effluent stream.

WASTEWATER TREATMENT TECHNOLOGIES

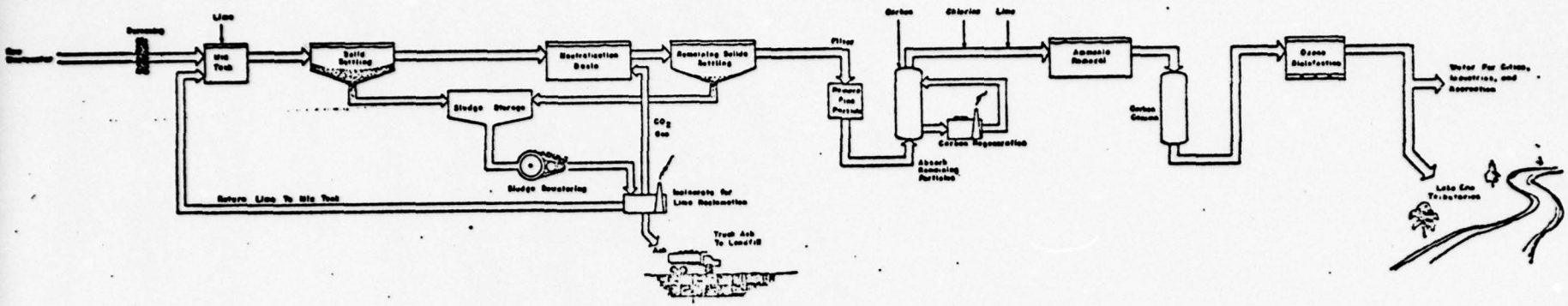
Introduction

Wastewater treatment depends upon two factors: the type of effluent desired and type of process or technology used to achieve it.

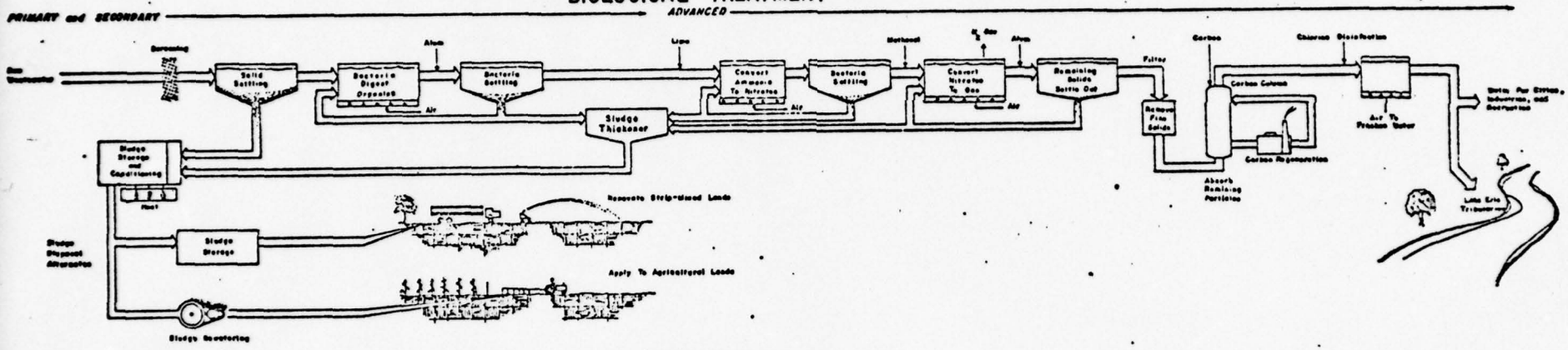
There are, generally speaking, three types of effluent -- primary, secondary and advanced treatment effluent. Primary treatment removes approximately 40 percent of the pollutants from wastewater by a settling process. Under secondary treatment, water is treated by a bacteriological process, such as trickling filters, activated sludge, or aerated laggons and settling. This is generally the highest level of treatment currently provided in the Three Rivers area and typically removes 85 percent of the pollutants. The third level of treatment is advanced treatment, which removes essentially all pollutants (99 percent) from wastewater, concentrating on nutrients which have not been removed by primary and/or secondary treatment.

The three final plans draw from the broad range of available wastewater treatment processes. The technologies of advanced treatment can be classified as biological-land treatment, advanced biological and physical-chemical. Biological treatment digests the organic pollutants in wastewater by bacteria, and chemical action coupled with settling completes the process. Physical-chemical technology functions by removing pollutants by chemical action, and gravity settling. The land treatment technology utilizes biological processes to achieve secondary treatment; the effluent is then applied to agricultural land where the water receives final treatment by flowing through the "living filter" of the soil. Diagrams of the three types of advanced treatment are given in Figure II-2.

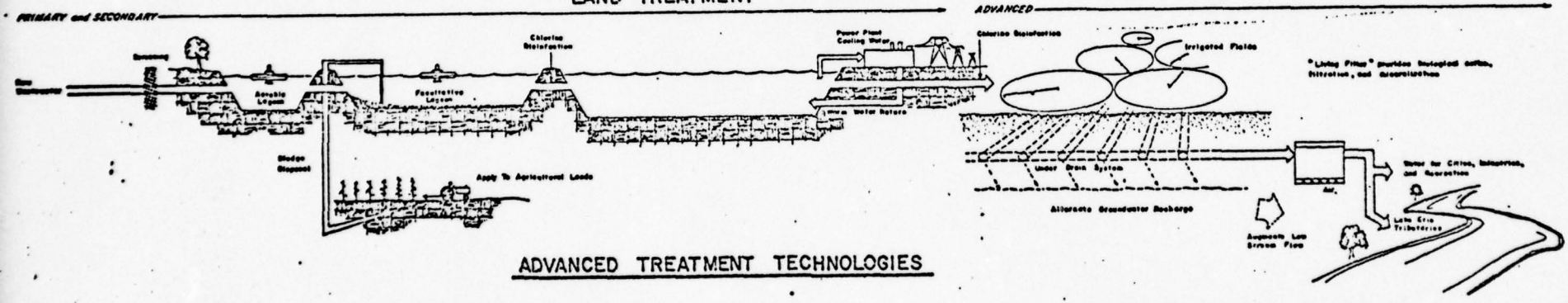
PHYSICAL-CHEMICAL TREATMENT



BIOLOGICAL TREATMENT



LAND TREATMENT

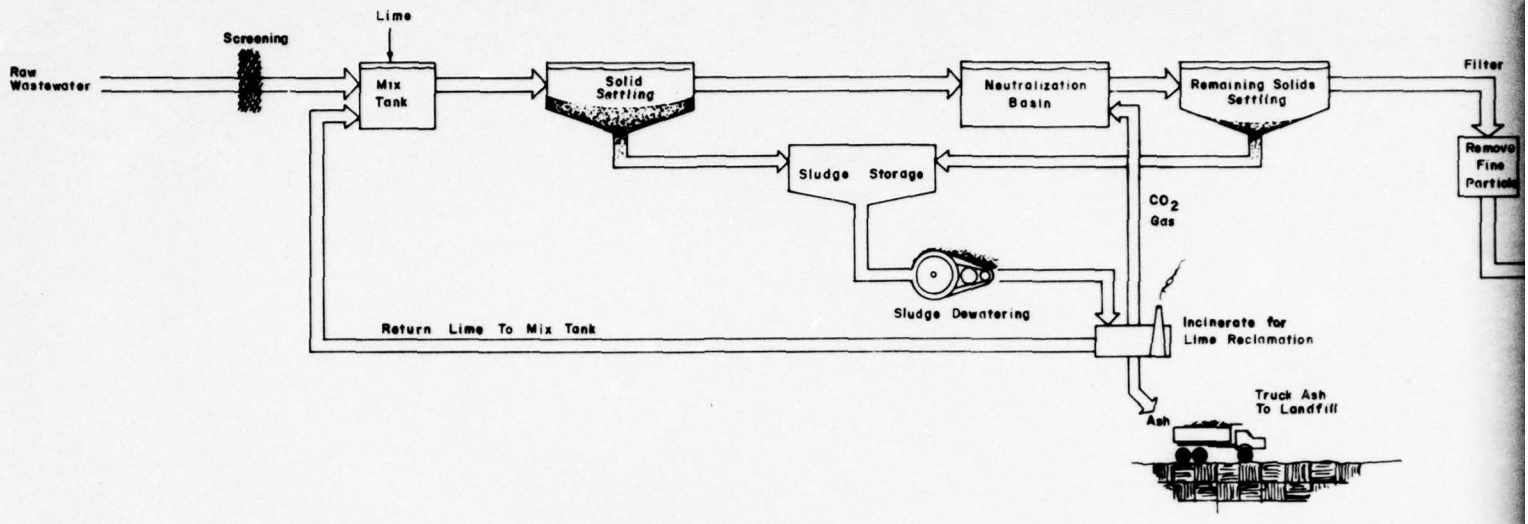


ADVANCED TREATMENT TECHNOLOGIES

FIGURE II-2

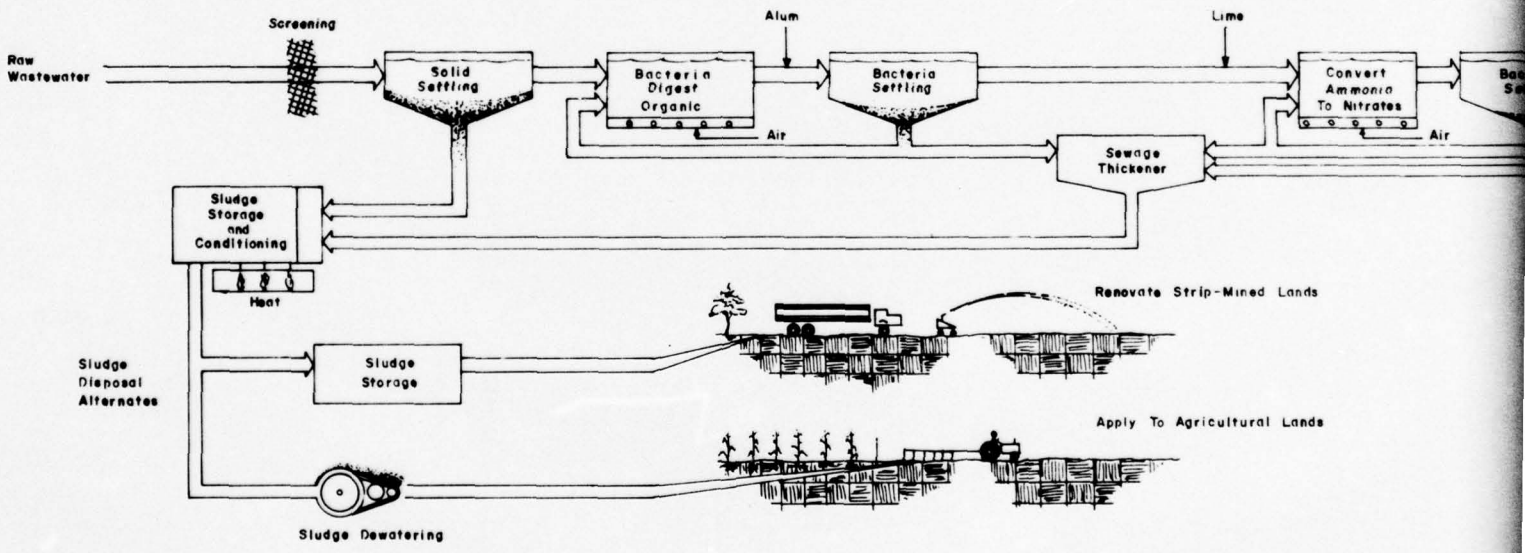
PHYSICAL-CHEMICAL TREAT

PRIMARY and SECONDARY → ADVANCED



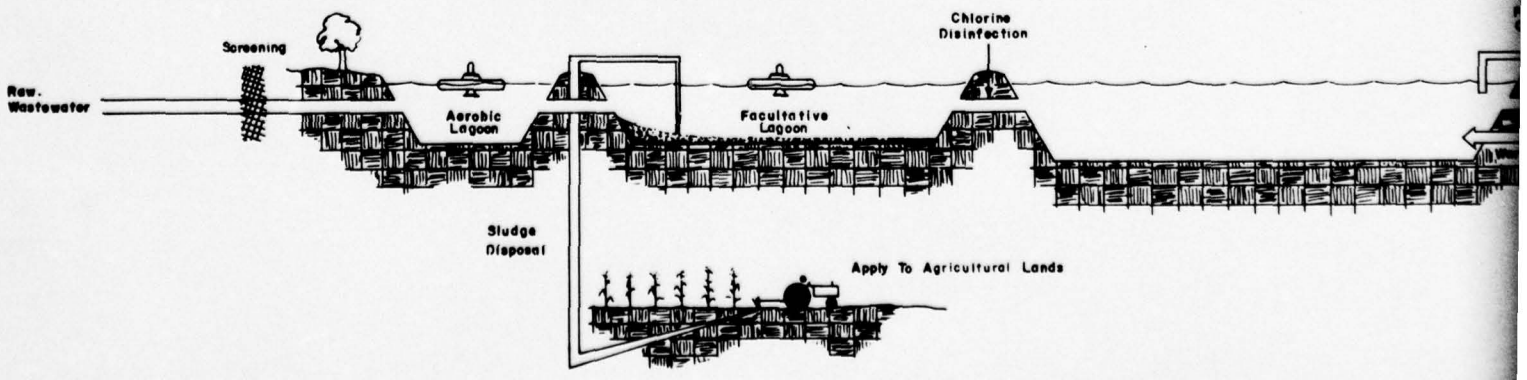
BIOLOGICAL TREATMENT

PRIMARY → SECONDARY → ADVANCED



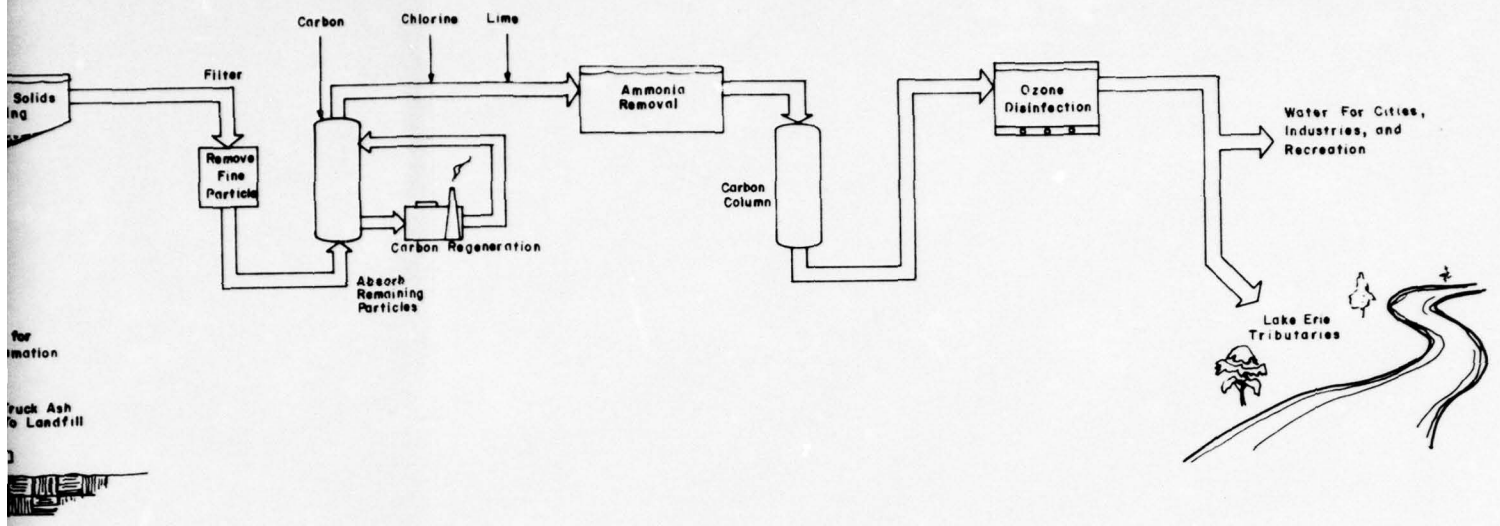
LAND TREATMENT

PRIMARY and SECONDARY



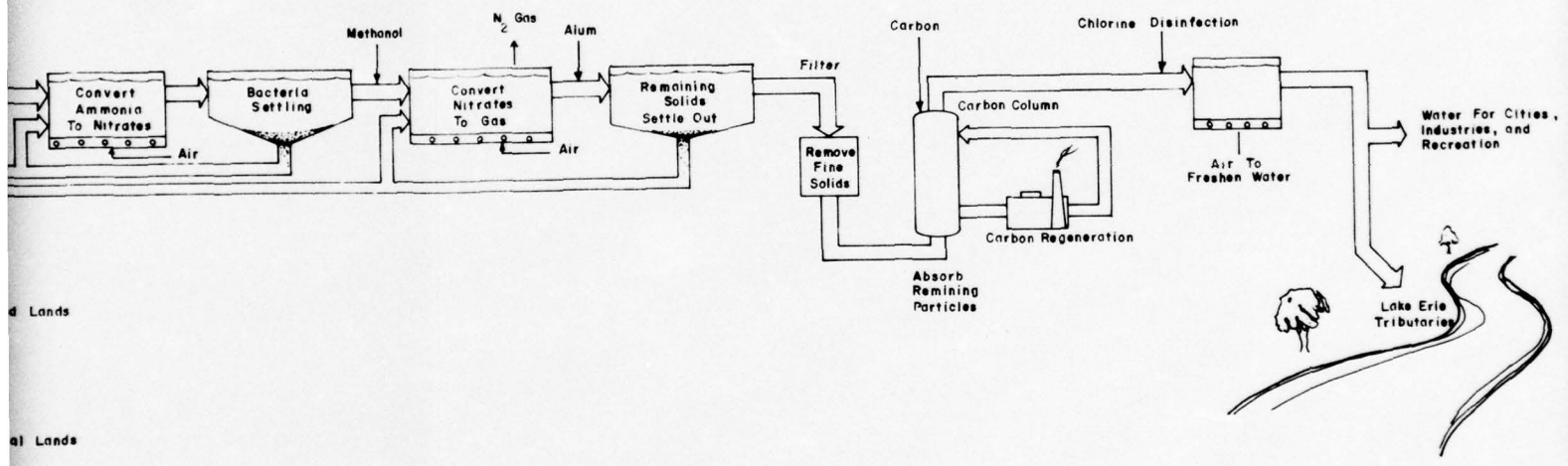
ADVANCED TREATMENT TECHN

EMICAL TREATMENT



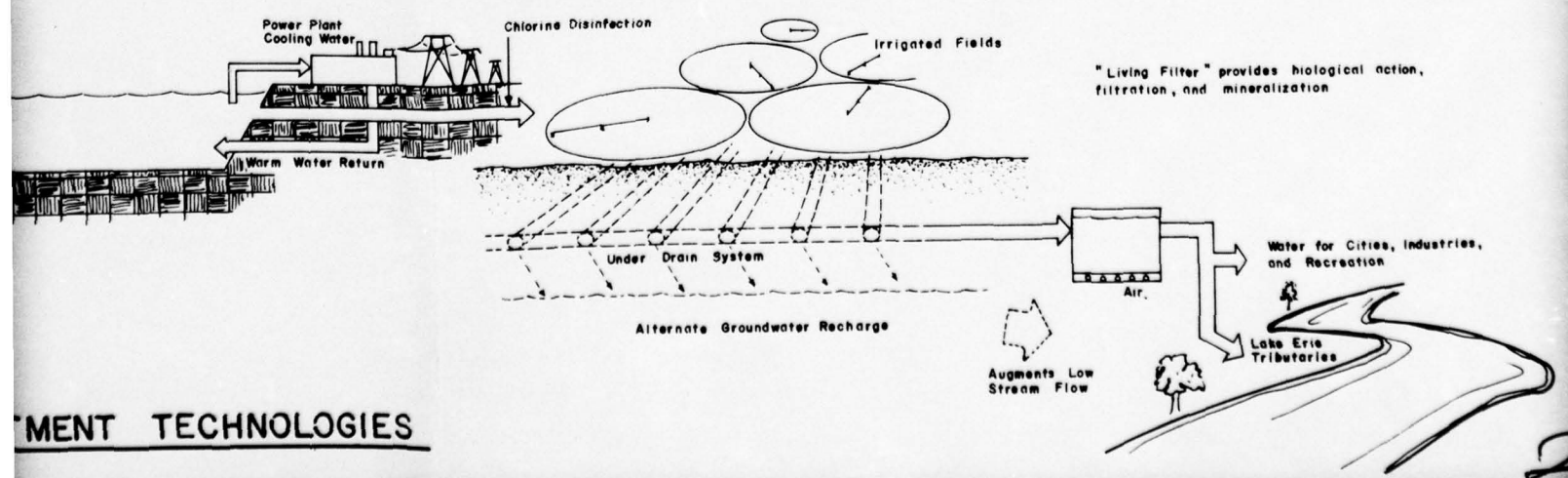
TREATMENT

NCED



MENT

ADVANCED



MENT TECHNOLOGIES

FIGURE II-

Advanced Biological Treatment

Paralleling nature, the advanced biological treatment process provides an environment for the growth of biological organisms as in the secondary treatment process. These organisms use the organic matter contained in wastewater as a source of food and are supplied with sufficient oxygen to complete the digestive process. Settling is then required to separate solids and bacteria from the water.

Removal of nutrients, taste and odor, and remaining suspended solids is the aim of the advanced treatment. Nitrogen and phosphorous are nutrients found in wastewater, which are harmful to bodies of water by causing accelerated eutrophication. Nitrifying bacteria are used to convert ammonia-nitrogen to a gaseous form which escapes into the atmosphere. Phosphorous is removed through biological uptakes, chemicals and filtration processes. As shown in Figure II-2, the treatment process includes filtration to remove fine particles.

It is possible to add components to the system to perform specific functions. Thus, existing sewage plants can sometimes by utilized with "add-ons" of advanced biological components.

This treatment produces solid by-products (sludge) suitable for agricultural applications. Properly controlled, sludge is a valuable resource for its fertilizer (nitrogen, phosphorous) use.

Operation and maintenance costs are those incurred by physical-chemical treatment but higher than those for land treatment. It requires a relatively high capital investment. Load fluctuations reduce treatment effectiveness and industrial spills can easily upset the biological processes. Plant operation and maintenance is fairly complex.

Land Treatment

This method of wastewater treatment utilizes the natural processes of the earth's soil zone and growing crops. Wastewater first undergoes secondary biological treatment in either an aerated lagoon or conventional activated sludge plant; the secondary effluent is then applied to agricultural or other suitable land by any of several irrigation techniques.

The soil biota, the filtration and chemical exchange capacities of the soil and its living organisms are collectively referred to as the "living filter". As the wastewater passes through the soil, the organic matter, bacteria and plant nutrients are removed. Within a few feet of the soil surface the water is clear, being similar to water obtained from wells.

The effect of land treatment is to recycle to the environment elements such as nitrogen and phosphorous discarded as pollutants by man but readily utilized by nature as nutrients.

The removal and storage capability of the soil for heavy metals is great enough that a site can be used for hundred of years, thus making it less important for industry to remove all of its metals in-house prior to secondary treatment. Land treatment provides a high degree of water purification including effective virus removal.

Operation and maintenance costs are generally lower than those incurred with advanced biological or physical-chemical plants, although power demands are higher. Extensive areas of land are committed to agriculture for long periods of time, winter storage reservoirs are required for the secondary effluent, present agricultural practices may have to

be altered, and land may not be readily available near the cities. Aerated lagoons require larger land areas and higher power use than would conventional activated sludge plants.

Physical-Chemical Treatment

Physical-chemical treatment evolved as a sophisticated method to remove complex wastewater constituents, but deviates from the processes we think of as "biological" or "natural". There is still a reliance upon physical separation of solids and water, although chemicals are used to stimulate and greatly enhance the efficiency of separation. In addition, the use of chemical treatment processes removes organic and inorganic material ordinarily unaffected by biological secondary treatment. Components may be added to remove specific pollutants.

This technology usually requires a fairly small land area and lower capital costs than biological or land treatment. It can withstand load fluctuations well, and is flexible for growth and operation. Certain chemicals can be reclaimed; however, incineration of the sludge is required for this process. Large chemical supply needs and high operation and maintenance costs, coupled with complex plant operation, make the physical-chemical plant less attractive. The beneficial use of the solid by-products may also be questionable depending upon local soil conditions.

SECTION II

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SECTION III

REVIEW OF TWELVE INITIAL PLANS

During the early stages of this study twelve regional wastewater management plans were formulated, based upon two water quality standards (Level 1 and Level 2), and a variety of wastewater treatment technologies, which are discussed in Section IV.

Plans 1, 3, 10, and 11 were predicated on all water-based treatment; Plans 2, 4, and 12 were based exclusively on land treatment; and Plans 5, 6, 7, 8 and 9 were combinations with varying emphasis on the two types of treatment. The formulation of twelve different plans allowed for the investigation of various approaches to the problems of discharge points for treated water, sludge disposal and urban stormwater collection and treatment.

The basic components for each of the plans are given in Table III-1. In order to facilitate cost comparisons among plans, an annual comparable cost was derived for each plan, based upon the capital and O & M costs of the individual plan components, given standard contingency factors. The costs of the twelve plans are summarized in Table III-2.

These twelve plans were subjected to intensive review and evaluation by the Center for Urban Regionalism at Kent State University, the Ohio Environmental Protection Agency, the Ohio Department of Natural Resources, and various state and local agencies. Numerous public meetings were conducted by the U. S. Army Corps of Engineers in the study area, as well as in Western Ohio. The details of the evaluation are presented in the Evaluation Appendix. Based on this evaluation, and a review of the contributions made by all participants, the U. S. Army Corps of Engineers identified three concepts

TABLE III-1

SUMMARY OF MAJOR COMPONENTS OF TWELVE ALTERNATE PLANS

ITEM	PLAN 1	PLAN 2	PLAN 3	PLAN 4
1. PLAN DESCRIPTION (REFERS TO TREATMENT OF DOMESTIC AND COMPATIBLE INDUSTRIAL FLOWS)	All Water-Based Level 1 Standards (Based on NE Ohio Plan)	All Land-Based Level 1 Standards	All Water-Based Level 2 Standards	All Land-Based Level 2 Standards
2. NUMBER OF WASTEWATER TREATMENT PLANTS - TYPE OF TREATMENT	26 Plants Tertiary treatment in added and expanded plant facilities as required to meet Level 1 Standards.	35 Plants Secondary treatment in added and expanded plant facilities prior to land treatment.	29 Plants Tertiary treatment in added and expanded plant facilities as required to meet Level 2 Standards. Combination Advanced Biological/Physical-Chemical Treatment.	34 Plants Same as Plan 2 and including land treatment of all storm runoff.
3. EFFLUENT TRANSMISSION FACILITIES AND DISCHARGE POINTS AFTER LEAVING TREATMENT PLANTS	Direct discharge to streams or into Lake Erie.	Flow from larger plants goes into Tunnel and thence to land area to west of Three Rivers Basin. Flow from smaller plants stays inside basin and goes via pipelines to local land treatment areas.	Same as Plan 1.	Same as Plan 2. Tunnel capacity increased to accommodate added stormwater flows.
4. ACREAGE (FOR MUNICIPAL-INDUSTRIAL WASTEWATER TREATMENT)				
OUTSIDE 3-RIVERS BASIN -	None	137,782 (net)	None	137,782 (net)
INSIDE 3-RIVERS BASIN -	None	20,846 (net)	None	20,846 (net)
5. SLUDGE DISPOSAL FACILITIES	Incineration locally with ash hauled to land-fill.	13 plants - via pipeline to strip-mined lands; 22 plants - agricultural land application.	10 plants - via pipeline to strip-mined lands; 12 plants - incineration and land-fill; 7 plants - agricultural land application.	19 plants - via pipeline to strip-mined lands; 15 plants - agricultural land application.
6. URBAN STORMWATER COLLECTION AND STORAGE FACILITIES INSIDE 3-RIVERS BASIN	Local treatment. Run-off districts combined where feasible. Discharge to streams or Lake Erie. Three-day storage for the 1-year storm volume.	Same as Plan 1.	Three-day storage for combined sewer 1-year storm overflows. Thirty-day stormwater storage provided for other drainage basins.	Same as Plan 3 except that drainage basins discharging to land treatment receive three days storage.
7. NUMBER OF URBAN STORMWATER TREATMENT PLANTS - TYPE OF TREATMENT	138 Plants Urban runoff is collected and treated locally by sedimentation-microstraining.	138 Plants or Coll. Points Some shoreline area runoff receives land treatment in western Ohio. In-basin plants are water-based.	None Urban runoff is treated at the wastewater treatment plants in off-peak hours.	40 Plants Treats stormwater in basin of origin on land when practicable. Other treatment similar to Plan 3 followed by land treatment.
8. ACREAGE (FOR URBAN STORM RUNOFF WASTEWATER TREATMENT)				
OUTSIDE 3-RIVERS BASIN -	None	8,565 (net)	None	29,988 (net)
INSIDE 3-RIVERS BASIN -	None	None	None	7,892 (net)

TABLE III-1 (Continued)

SUMMARY OF MAJOR COMPONENTS OF TWELVE ALTERNATE PLANS

ITEM	PLAN 5	PLAN 6	PLAN 7	PLAN 8
1. PLAN DESCRIPTION (REFERS TO TREATMENT OF DOMESTIC AND COMPATIBLE INDUSTRIAL FLOWS)	Combination Land/Water (Water Emphasis) Level 1 Standards	Combination Land/Water (Land Emphasis) Level 1 Standards	Combination Land/Water (Water Emphasis) Level 2 Standards	Combination Land/Water (Land Emphasis) Level 2 Standards
2. NUMBER OF WASTEWATER TREATMENT PLANTS - TYPE OF TREATMENT	36 Plants Tertiary treatment to Level 1 Standards for large and medium size plants. Secondary treatment prior to land treatment for smaller in-basin service areas.	37 Plants Tertiary treatment to Level 1 Standards for medium size plants. Secondary treatment in-basin prior to land application in W. Ohio for large plants. Secondary followed by land treatment for smaller in-basin areas.	29 Plants Same as Plan 5 with add-on facilities at tertiary plants to satisfy Level 2 Standards.	34 Plants Same as Plan 6 with add-on facilities at tertiary plants to satisfy Level 2 Standards.
3. EFFLUENT TRANSMISSION FACILITIES AND DISCHARGE POINTS AFTER LEAVING TREATMENT PLANTS	Flows from all plants remain inside Three Rivers Basin and are discharged to Lake Erie, streams or in-basin land treatment areas.	Same as Plan 2 for larger shoreline plants. For other areas - via pipelines to local land treatment or direct discharge to streams or Lake Erie.	Same as Plan 5.	Same as Plan 6. Tunnel capacity and land treatment area increased to accommodate added stormwater flows.
4. ACREAGE (FOR MUNICIPAL-INDUSTRIAL WASTEWATER TREATMENT)				
OUTSIDE 3-RIVERS BASIN -	None	63,968 (net)	None	101,004 (net)
INSIDE 3-RIVERS BASIN -	5,359 (net)	14,300 (net)	5,359 (net)	19,374 (net)
5. SLUDGE DISPOSAL FACILITIES	4 plants - via pipeline to strip-mined lands; 14 plants - incineration and land-fill; 18 plants - agricultural land application.	7 plants - via pipeline to strip-mined lands; 6 plants - incineration and land-fill; 24 plants - agricultural land application.	6 plants - via pipeline to strip-mined lands; 9 plants - incineration with ash to land-fill; 14 plants - agricultural land application.	9 plants - via pipeline to strip-mined lands; 6 plants - incineration with ash to land-fill; 19 plants - agricultural land application.
6. URBAN STORMWATER COLLECTION AND STORAGE FACILITIES INSIDE 3-RIVERS BASIN	Same as Plan 1.	Same as Plan 1.	Same as Plan 3.	Same as Plan 4.
7. NUMBER OF URBAN STORMWATER TREATMENT PLANTS - TYPE OF TREATMENT	123 Plants Treatment mostly water-based, similar to Plan 1, with minor amount treated on land areas.	125 Plants or Collection Points. Treatment mostly water-based. Some shoreline area runoff receives treatment in western Ohio land.	29 Plants Use of Physical-Chemical Stormwater Treatment Plants to achieve higher level of treatment as required when effluent is to water. Other treatment similar to Plans 3 and 4.	43 Plants Same as Plan 7.
8. ACREAGE (FOR URBAN STORM RUNOFF WASTEWATER TREATMENT)				
OUTSIDE 3-RIVERS BASIN -	None	5,762 (net)	None	22,404 (net)
INSIDE 3-RIVERS BASIN -	Trace	None	1,344 (net)	5,809 (net)

TABLE III-1 (Continued)

SUMMARY OF MAJOR COMPONENTS OF TWELVE ALTERNATE PLANS

ITEM	PLAN 9	PLAN 10	PLAN 11	PLAN 12
1. PLAN DESCRIPTION (REFERS TO TREATMENT OF DOMESTIC AND COMPATIBLE INDUSTRIAL FLOWS)	Combination Land/Water Level 2 Standards	All Water-Based (Advanced Biological) Level 2 Standards	All Water-Based (Physical-Chemical) Level 2 Standards	All Land-Based (Aerated Lagoons) Level 2 Standards
2. NUMBER OF WASTEWATER TREATMENT PLANTS - TYPE OF TREATMENT	11 Plants Wastewater from shoreline areas receives aerated lagoon secondary treatment in W. Ohio prior to land application. Several large tertiary facilities in-basin with land treatment in the upper Cuyahoga and at Randolph.	29 Plants Tertiary treatment in added and expanded plant facilities as required to meet Level 2 Standards. All Advanced Biological treatment.	29 Plants Tertiary treatment in added and expanded plant facilities as required to meet Level 2 Standards. All Physical-Chemical treatment.	34 Plants Secondary treatment in aerated lagoon facilities including land treatment of all storm runoff.
3. EFFLUENT TRANSMISSION FACILITIES AND DISCHARGE POINTS AFTER LEAVING TREATMENT PLANTS	Tunnel to W. Ohio from 4 in-basin load points. Remainder of treatment mostly at large tertiary facilities in-basin w/stream discharge.	Same as Plan 1.	Same as Plan 1.	Same as Plan 2. Tunnel capacity increased to accommodate added stormwater flows.
4. ACREAGE (FOR MUNICIPAL-INDUSTRIAL WASTEWATER TREATMENT)				
OUTSIDE 3-RIVERS BASIN -	62,358 (net)	None	None	108,402 (net)
INSIDE 3-RIVERS BASIN -	1,692 (net)	None	None	42,806 (net)
5. SLUDGE DISPOSAL FACILITIES	4 plants - W. Ohio agricultural land application; 5 plants - incineration with ash to land-fill; 2 plants - agricultural land application.	20 plants - via pipeline to strip-mined lands; 9 plants - agricultural land application.	All plants use incineration with chemical reclamation. Residue ash hauled to land-fill.	25 plants - agricultural land application; 9 plants - agricultural land application in western Ohio.
6. URBAN STORMWATER COLLECTION AND STORAGE FACILITIES INSIDE 3-RIVERS BASIN	Same as Plan 3. Some basins release directly to Effluent Transmission Tunnel	Same as Plan 3.	Same as Plan 3.	Same as Plan 4.
7. NUMBER OF URBAN STORMWATER TREATMENT PLANTS - TYPE OF TREATMENT	None Same as Plan 3.	None Same as Plan 3.	None Same as Plan 3.	48 Plants Same as Plan 4 except Akron area stormwater is stored at one large facility.
8. ACREAGE (FOR URBAN STORM RUNOFF WASTEWATER TREATMENT)				
OUTSIDE 3-RIVERS BASIN -	13,765 (net)	None	None	24,636 (net)
INSIDE 3-RIVERS BASIN -	629 (net)	None	None	11,021 (net)

TABLE III-2

MUNICIPAL, STORM AND INDUSTRIAL WASTEWATER TREATMENT
COMPARABLE ANNUAL COST INDICES - YEAR 2020
FOR FORMULATED PLANS
(COSTS IN $1000)

	MUNICIPAL				STORM				INDUSTRIAL				
	1	2	3	4	5	6	7	8	9	10	11	12	13
FORMULATION PLAN NUMBER	NET CAPITAL INVESTMENT	ANNUAL CAPITAL COST	ANNUAL O&M COST	ANNUAL COMPARABLE VALUE (2 + 3)	NET CAPITAL INVESTMENT	ANNUAL CAPITAL COST	ANNUAL O&M COST	ANNUAL COMPARABLE VALUE (6 + 7)	NET CAPITAL INVESTMENT	ANNUAL CAPITAL COST	ANNUAL O&M COST	ANNUAL COMPARABLE VALUE (10 + 11)	TOTAL ANNUAL COMPARABLE VALUE (4 + 8 + 12)
1	496,400	37,900	64,600	102,500	1,480,300	110,300	13,400	123,700	238,900	17,400	23,800	41,200	267,400
2	1,610,000	119,200	59,700	178,900	1,493,400	114,300	13,900	128,200	183,300	13,300	21,600	34,900	342,000
3	811,100	62,200	86,300	148,500	3,356,300	245,900	48,200	294,100	363,000	26,300	38,400	64,700	507,300
4	1,614,400	120,900	62,300	183,200	2,697,000	201,400	28,400	229,800	183,300	13,300	21,600	34,900	447,900
5	580,100	44,500	65,300	109,800	2,065,400	153,500	20,600	174,100	238,900	17,400	23,800	41,200	325,100
6	1,153,700	87,000	62,500	149,500	2,051,100	152,800	20,300	173,100	193,600	14,000	21,400	35,400	358,000
7	824,700	63,400	81,100	144,500	2,228,100	164,600	38,400	203,000	363,000	26,300	38,400	64,700	412,200
8	1,444,400	108,800	71,700	180,500	2,299,500	172,500	29,800	202,300	206,100	14,900	24,300	39,200	422,000
9	1,263,600	95,200	71,500	166,700	3,095,800	227,700	39,100	266,800	270,300	19,600	29,600	49,200	482,700
10	838,600	64,200	84,300	148,500	3,350,600	245,500	47,000	292,500	363,000	26,300	38,400	64,700	505,700
11	603,300	50,500	94,100	144,600	3,219,600	235,200	41,500	276,700	363,000	26,300	38,400	64,700	486,000
12	1,252,400	95,000	46,000	141,000	2,116,900	161,600	22,800	184,400	176,000	12,800	20,300	33,100	358,500

for further development based upon Plans 1, 7, and 8. These concepts were:

1. All water-based treatment;

2. A combination of water-based treatment for the densely populated metropolitan areas, with land treatment for the smaller communities in the Study Area;

3. Land treatment in-basin for the smaller communities, and transmission of storm and wastewaters from the densely populated shoreline region of the Study Area to a land treatment site lying to the west.

These concepts were incorporated in Plans A, B, and C respectively.

Plan 1 was, in essence, the Northeast Ohio Plan, which met Level 1 Standards and included some treatment of storm runoff. Therefore, the evolution of Plan A from Plan 1 required upgrading treatment to meet Level 2 Standards for municipal/industrial wastewater and storm runoff. Of prime importance in the selection and development of Plan A was the fact that it represented the NEO Plan on which significant public monies had already been spent, and for which several years of effort had been made. In addition, it represented a composite of planning by many of the most knowledgable engineering firms of Ohio.

The development of Plan B required optimizing upper basin land treatment for municipal/industrial effluent and storm runoff. A further condition was that the components of Plan B had to be identical with the corresponding components of either Plan A or Plan C.

A basic alternative to advanced wastewater treatment with water discharge was the objective in Plan C. In addition to the land treatment components located in the Study Area, Plan C provides for ultimate land-based treatment for the municipal/industrial wastewater and stormwater generated in the Lake Erie shoreline region of the Study Area. The treatment of wastewater

from this shoreline region is accomplished by transmission through a tunnel to a land treatment site situated within the Lake Erie drainage basin to the west of the Study Area. This centralized treatment complex has been designated the Western Land Treatment Area.

SECTION IV

DESCRIPTION OF SELECTED PLANS

The earlier phases of the Survey Scope Study developed basic data and schematic designs necessary to formulate a wide range of alternative wastewater management plans for the Cleveland-Akron/Three Rivers Watershed Areas. Included in these plans were various treatment processes, degrees of regionalization, and innovative approaches to wastewater management. This section of the report presents three final plans, selected from among the initial set of twelve alternatives. The plans have been further refined and set into phased schedules for implementation. Cost estimates for the three plans are presented in Section V.

Plans A, B and C each represent a comprehensive wastewater management program phased to meet the water quality standards described in Section II and designed for the projected growth within the Study Area. Each plan includes treatment for three categories of wastewater: municipal, industrial and urban storm runoff. Each plan provides treatment for the same total volumes of wastewater, as shown in Tables IV-1, 2, 3 and 13.* The methods of treatment, combinations of facilities and sludge disposal techniques vary between plans. Thus Plans A, B and C are uniform in scope and in standards of performance, but illustrate different design concepts. Phase 3 of the Survey Scope Study has attempted to optimize the formulation of each plan.

Three categories of wastewater treatment, physical-chemical, biological, and land, are referred to in this report. The term "water-based treatment"

* All tables and figures at end of this Section.

includes both physical-chemical and biological processes, which discharge treated effluent directly to natural watercourses, rather than as return flow following land application. The three methods were outlined briefly in Section II and are defined in detail in the Havens and Emerson, Ltd. and Wright-McLaughlin Engineers Phase II Reports.

General discussions of industrial pre-treatment, sludge handling and disposal, and storm runoff treatment follow in this section. Plans, A, B, and C are then described, with details of each plan presented in tabular form, at the end of this section.

INDUSTRIAL WASTEWATER TREATMENT

The magnitude of the industrial wastewater problem in the Study Area and the special requirements of industrial wastewater treatment necessitated a separate investigation of this aspect of the total wastewater management problem. Associated Water and Air Resources Engineers, Inc. performed studies of industries within the Study Area and projected costs for "in-house" wastewater treatment by industry. Some industrial wastewaters will be discharged directly to natural watercourses following complete treatment in-house, and some will be released to the municipal sewer system following industrial pre-treatment to achieve compatibility with municipal sanitary sewage. The estimated future contributions of industrial wastewater to municipal systems have been included in Table Nos. IV-1, 2, and 3, "Municipal/Industrial Wastewater Treated by Decade", and these industrial flows have been accounted for in the sizing of all treatment and transmission facilities in Plans A, B, and C.

Five possible levels of industrial pre-treatment were discussed and costed on a present-worth basis in AWARE's Phase II Report. These alternatives varied substantially in cost depending upon their removal criteria, and it was thought that cost savings might be realized by matching different industrial pre-treatment alternatives to water-based and land-based final treatment, respectively. The present-worth costs displayed in Tables V-1 and V-2 include costs for AWARE's industrial treatment Alternative 3 for all three plans. Alternative 3 provides for the most complete in-house industrial treatment and is the most expensive of the five.

SLUDGE HANDLING AND DISPOSAL - PLANS A, B, AND C

Sludge handling and disposal is an integral part of each of the three wastewater treatment plans, requiring an average of 16 per cent of the capital expenditures and 10 per cent of the yearly operation and maintenance costs for municipal/industrial treatment. As such, the selection of a sludge disposal system for each wastewater treatment plant must give consideration to: (1) plant location and type, (2) sludge characteristics, (3) sludge quantities, (4) public attitudes, (5) land availability, (6) soil conditioner requirements, (7) climate, and (8) economic feasibility. Throughout this study, an effort was made to obtain a balance between these considerations in choosing the methods of sludge treatment.

Proper sludge handling and disposal techniques are necessary to: (1) produce a relatively stable material from the decomposition of

organic sludge matter, (2) reduce sludge volumes, (3) destroy and/or control pathogenic organisms, (4) provide a nutrient-rich resource for soil conditioning, and (5) maximize economic benefits from solid waste matter.

Sludge Generation

The characteristics and quantities of sludge generated are dependent upon the treatment process and the required level of effluent quality.

In their Phase II Report, "Systems Design and Estimates of Cost", (October 1972), Havens and Emerson, Ltd. described the preliminary treatment plant, conventional activated sludge plant, advanced biological treatment plant (Level 1 and Level 2) and the physical-chemical treatment plant (Level 2), along with the sludge quantities generated for each. These quantities, in dry tons per million gallons (TPD/MGD), are as follows:

Conventional Activated Sludge	0.645 TPD/MGD
Advanced Biological Treatment Plant (Level 1)	1.06 TPD/MGD
Advanced Biological Treatment Plant (Level 2)	1.14 TPD/MGD
Physical-Chemical Treatment Plant (Level 2)	0.86 TPD/MGD*

* TPD of waste ash from recalcination furnace.

Reductions in the volume of sludge generated occur through sludge digestion and dewatering. Digestion reduces the solids (dry tons of sludge generated in the conventional activated sludge process to 53 per cent of its originalweight and to 64 per cent for the advanced

biological treatment plants. Digestion and vacuum-filtration dewatering together produce quantities of 60 and 64 per cent of the dry tons of sludge generated from the conventional activated sludge and advanced biological treatment plants, respectively.

The use of aerated lagoons as an alternative secondary biological treatment process is discussed in Wright-McLaughlin's Report "Land Treatment Phase II," (December 1972). The aerated lagoons provide for solids deposition which undergo anaerobic and some aerobic decomposition. The net effect is to produce lower volumes of sludge to be periodically removed for disposal. The quantity of sludge generated for disposal was determined to be 0.21 TPD/MGD.

The quantities of sludge to be disposed of for each plant in Plans A, B, and C are listed in Tables IV-4, 5, and 6.

Sludge Disposal

Various methods of sludge treatment and disposal were investigated throughout the course of this study. For the conventional activated sludge process and the advanced biological treatment plants (Levels 1 and 2) sludge digestion was the minimum treatment received at each plant. Some require additional preparation which includes flash drying, vacuum-filtration and/or incineration. Aerated lagoon sludge was felt to be stable enough prior to disposal to eliminate further digestion processes.

The disposal methods chosen all utilized land treatment (or land-

fill in the case of incinerated sludge) as the final step but varied in the preceding preparatory techniques, so that sludge was either vacuum filtered, dried on a sand bed, trucked as a liquid, or pumped prior to disposal.

Cost comparisons were critical factors in determining the method of treatment for each plant. Studies, however, indicated that natural "break points" in costs occurred when plotted against the size of the wastewater treatment facilities. These, in conjunction with phasing requirements, assisted in the selection of sludge treatment schemes and account for variations between plants.

A complete listing of the sludge disposal method for each wastewater treatment plant in Plans A, B, and C is given in Tables IV-10, IV-11, and IV-12, "Sludge Disposal".

Soil Conditioning

Evidenced by Tables IV-10, 11, and 12 is the dominant use of sludge for land treatment. This is due to its good nutritional (nitrogen, phosphorus, potassium, and micronutrients) value as a plant fertilizer and its ability to build up soil humus. At the same time, the use of sludge as a soil conditioner provides the opportunity to conserve natural resources.

Barren strip-mined lands can also benefit from the application of sewage sludge. Several demonstration projects indicate that heavy applications of 100 to 200 tons per acre help transform acid strip mines into forest, farm land, and conservation or recreation areas.

Figure IV-6 shows the route of a pipeline to strip mines in Harrison County, Ohio, which is included in Plans A and B as a major component of the sludge disposal system after 1990. The Transmission Tunnel in Plan C removes the sludge from the major shoreline treatment plants by 1990 and 2000, so that strip-mine reclamation is not included in the sludge disposal formulation for Plan C.

STORM RUNOFF

The Survey Scope Study has been directed towards developing wastewater management plans with the capability of achieving high standards of water quality in receiving rivers and Lake Erie. Collection and treatment of polluted urban storm runoff is necessary to reach the stated goals of this study.

The Phase I Report of Havens and Emerson, Ltd. defines storm runoff volumes and pollutant loadings for the Study Area. For this purpose, 162 drainage districts were identified corresponding to the areas which are expected to be significantly urbanized by the year 2020. Figure IV-7 at the end of this section shows the locations of the drainage districts. Plans A, B, and C each define the method of storm runoff treatment for the individual districts in Tables IV-14, 15, and 16. A summary of these data is presented in Table IV-13, which shows the total average annual flow treated in each decade by the several general methods included in each plan. The total volumes to be treated increase steadily with time, both because additional land areas become

urbanized and require collection of storm runoff and because areas already "urbanized" become more densely populated with a corresponding increase in the amount of surface area covered by impervious pavement and rooftops, thus generating more runoff per acre of land. Storm runoff from rural areas (less than ten per cent impervious) has not been included for collection and treatment in this study.

A characteristic of storm runoff, as compared with municipal/industrial wastewater, is its extreme variability in rate of flow. The stormwater treatment systems in this plan accordingly include detention basins as flow-leveling devices to minimize the capacities required for "downstream" transmission and treatment facilities. In the more densely urbanized portions of the Study Area, these detention basins are designed to be covered and to be constructed of concrete, resulting in relatively high costs. The locations of concrete and earthen detention basins are shown on Figures IV-1, 2, and 4 for Plans A, B, and C, respectively. An important factor affecting costs for stormwater, is, therefore, the capacity required for detention storage. Tables IV-14, 15, and 16, "Storm Runoff Treatment," present specific design data for the volume of each detention basin and the rate at which it would be emptied. Since these data were computed differently for the various combinations of detention basin types and treatment types, a separate column headed "Sizing Options" in the tables indicates by a letter which of the following six pairs of criteria were used in the calculations for each basin.

A. In the case of a concrete detention basin preceding an advanced stormwater treatment plant, mechanical sludge collection is included in the basin design, and two-hour detention storage is provided.

Detention Basin Volume (MG) = (0.28 x one-year storm volume in MG) + (0.0162 x peak flow in cfs)

Rate of Treatment (MGD) = .30 x one-year storm peak flow in MGD.

B. In the case of a concrete detention basin preceding treatment in a municipal sewage treatment facility, mechanical sludge collection is included in the basin design, and three-day detention storage is provided.

Detention Basin Volume (MG) = One-year storm volume.

Rate of Release (MGD) = One-year storm volume ÷ three days.

C. In the case of a concrete detention basin preceding discharge directly to the Transmission Tunnel, two modes of detention storage are used to level the flow carried by the Tunnel. The concrete detention basin, which includes mechanical sludge collection, is sized as follows:

Detention Basin Volume (MG) = 0.33 x one-year storm volume.

Rate of Release (MGD) = (0.33 x one-year storm volume) ÷ three days

In addition, mined storage chambers above the normal hydraulic grade line of the tunnel provide detention capacity for the balance of the storm runoff surcharge to the tunnel.

Mine Storage Volume (MG) = Approximately 0.40 x one-year storm volume. (Balance direct to tunnel).

Rate of Release is controlled by the level of the hydraulic grade line (less than three days).

D. In the case of an earthen detention basin preceding an advanced stormwater treatment plant, three-day detention is provided for the one-year storm.

Detention Basin Volume (MG) = One-year storm volume.

Rate of Treatment (MGD) = One-year storm volume ÷ three days.

E. In the case of an earthen detention basin from which the stormwater is pumped directly to a land treatment facility, three-day detention is provided for 20 percent of the annual runoff.

Detention Basin Volume (MG) = 0.2 x annual runoff in MG.

Rate of Pumping (MGD) = (0.2 x annual runoff)/three days.

F. In the case of an earthen basin preceding treatment in a municipal facility, thirty-day detention is provided.

Detention Basin Volume (MG) = 0.20 x annual runoff in MG.

Rate of Release (MGD) = (0.20 x annual runoff) ÷ 30 days.

The one-year storm hydrographs used for design purposes are based upon the 6-hour duration storm.

PLAN A

All treatment is water-based in Plan A. It represents the Northeast Ohio Plan for wastewater management upgraded to Level 2 Standards for municipal/industrial wastewater and storm runoff treatment. See Figure IV-1.

The plan is regional, with a total of 26 proposed municipal plants; eight are now in existence. Municipal sewage is given advanced biological treatment in all plants except Cleveland Westerly, Rocky River, and Kent, where physical-chemical treatment is utilized. Table IV-1 tabulates the hydraulic loadings of the municipal/industrial treatment plants, and Table IV-7 describes treatment processes and construction phasing for each municipal plant. The construction is phased to meet current appropriate State of Ohio Standards, and Level 1 and 2 Standards as outlined for the target dates of 1977, 1983, and 1985.

Approximately 43 percent of stormwater runoff* is treated in municipal plants during off-peak hours. The remaining 57 percent is treated in 81 separate advanced stormwater treatment plants. Stormwater volumes and proposed treatment methods are listed in Tables IV-13 and IV-14.

Sludge generated by wastewater and storm runoff treatment will be disposed of by several methods. Until 1990, the larger plants will either incinerate, or apply sludge to agricultural land. After 1990, some incineration will continue, and two pipelines will convey sludge either to agricultural or strip-mined land. Sludge from the smaller plants will be trucked to adjacent agricultural land. Sludge volumes generated by

* urban storm runoff where imperviousness is greater than 10 per cent.

municipal/industrial wastewater are given in Table IV-4. Sludge disposal is described in Table IV-10, and illustrated in Figure IV-6.

Treatment Plant Site Selection

The Northeast Ohio Plan, a major study completed in 1972, favored regionalization of wastewater treatment facilities for the following reasons:

1. A large plant is more adaptable to technological changes, and these changes are more apt to be incorporated in larger plants.
2. A single effluent discharge is easier to monitor and regulate than several input points.
3. Generally, as regionalization and the combining of areas takes place, the effluent discharge point may be located where the impact on stream flow is lessened.
4. Scale economies occur both in new construction and in operation and maintenance.
5. The impact from slug loads, variations in flow, and industrial loads are reduced.
6. The duplication of treatment units in large plants minimizes the impact of maintenance outages.

The rationale of the NEO Plan regarding plant site selection is presented as described by Burgess and Niple. It formed an important basis for plant site selection in Plan A.

Rocky River Basin. The correction of present municipal wastewater deficiencies will include expansion and additional treatment at several plants for the interim period until the Southwest Interceptor of the Cleveland Southerly plant is constructed and can serve the area. The long-range management

strategy requires that all municipal wastewater stream discharges within Cuyahoga County be exported to the Cleveland Southerly plant. This is required to protect the high recreational use of the Rocky River in the Cleveland Metropolitan Park area.

Cuyahoga River Basin. The management strategy for this basin is to gradually establish complete regionalization of collection and treatment systems in the lower basin. The Cleveland and Akron systems would expand to meet generally along the Ohio Turnpike. Smaller regional systems would evolve upstream of the Akron system around Kent, Ravenna, and Aurora. All waste discharges into the Cuyahoga River between the Akron plant and Cleveland Southerly plant would be eliminated to protect the recreation river corridor existing and proposed for this reach of the stream. Many wastewater treatment plants in the Akron and Cleveland service areas must be expanded in both capacity and level of treatment on an interim basis until they can be phased out by construction of interceptors.

Additional interceptors must be constructed along the lower Cuyahoga River, capable of carrying one-year storm flows and conveying them to a storm water treatment facility. To meet water quality standards in the ship channel specific positive reaeration devices must be installed.

It is estimated that construction of all the corrective action listed above will require the rest of this decade for construction. Water quality standards can be achieved, upstream of the ship channel by 1977. The ship channel can be restored by 1980. As a part of the water quality program, many treatment plants will be abandoned throughout the entire basin. These sites are recommended for conversion to stream access points.

Chagrin River Basin. For this river basin, the critical waste constituents which must be corrected include suspended solids, BOD, acids, and temperature.

The long-range management strategy is to effect some regionalization of small treatment plants into nine service areas.

Many small treatment plants will be retired in this basin. The sites are recommended for conversion to stream access points.

PLAN B

Plan B combines the technologies of advanced water-based treatment and land treatment. The unique aspect of Plan B is that all features are identical to either Plan A or Plan C.

The similarity to Plan A lies in nine large municipal plants which are common to both plans. These include Cleveland Southerly, Akron, New Kent and six plants located on or near the Lake Erie shoreline. As in Plan A, Cleveland Westerly, Rocky River, and New Kent are physical-chemical plants; the remainder are advanced biological plants. All other wastewater treatment facilities located in the upper reaches of the Three Rivers are aerated lagoon/land treatment facilities. Figure IV-2 illustrates the plan. A tabulation of the municipal plants with the volumes of municipal/industrial wastewater treated, is presented in Table IV-2. Table IV-8 shows the treatment processes involved and the phasing of construction. Construction phasing of the facilities provides for meeting Level 1 and Level 2 Standards specified for 1977, 1983, and 1985.

Wastewater treatment facilities in Plan B include nine municipal water-based treatment plants, twenty-two municipal aerated-lagoon/land treatment systems; thirty-nine advanced stormwater treatment plants, and forty-six separate stormwater land treatment sites. By the year 2020 approximately 42% of the projected annual volume of stormwater to be treated is routed to advanced stormwater treatment plants, 40% to municipal water-based treatment plants, 4% to municipal aerated lagoons and 14% to separate land treatment sites. Storm runoff treatment, by drainage district, is defined in Table IV-15 for Plan B.

Sludge disposal for Plan B is quite similar to Plan A; it is accomplished by incineration, and application to agricultural and strip-mined land. An existing pipeline will transport sludge from Willoughby-Eastlake to strip-mined disposal areas until 1990. After 1990, a new pipeline will convey sludge from Euclid, Cleveland Easterly, Cleveland Southerly, and Akron to strip-mined land; a second pipeline will carry sludge from Willoughby-Eastlake to agricultural land. These pipelines and the disposal areas are indicated in Figure IV-6. Sludge volumes produced by municipal/industrial wastewater are given in Table IV-5, and sludge disposal methods are described in Table IV-11.

In Plan B, plant site selection was based upon the objective of providing land treatment where appropriate sites existed in reasonable proximity to the smaller plant locations. The larger water-based plants would be sited in a manner identical to that in the Northeast Ohio Plan.

PLAN C

This plan utilizes land treatment technology as part of a comprehensive regional wastewater scheme. The plan has four basic divisions:

1. Eight advanced water-based plants located on or near the Lake Erie Shoreline. They are phased out in two groups in the years 1990 and 2000 respectively.
2. The Western Land Treatment Area. This subsystem commences operation in 1985, works in conjunction with the Lake Erie Shoreline plants during the phase-out period from 1990 to 2000, and provides total treatment for wastewater generated in the Cleveland metropolitan area after 2000.
3. Twenty-three aerated lagoon/land treatment facilities located in the upper river basins.
4. The advanced biological treatment plant at Akron.

These four elements provide treatment for all the municipal/industrial wastewater generated in the Study Area and for part of the stormwater. In 1990, 66 percent of stormwater runoff will be treated at the Western Land Treatment Area, four percent by in-basin aerated lagoon/land treatment, and two percent by the Akron plant. The remaining stormwater will be treated either by advanced stormwater treatment plants (21 percent) or by storage and land treatment (seven percent). By the year 2020, the percentage of water treated in-basin will be greater; the Western Land Treatment Area will then treat approximately 55 percent of the stormwater runoff.

The land treatment system has eight basic components:

1. A collection system, which may be expanded to serve growing areas;

2. Biological treatment cells or conventional secondary treatment plants;

3. Transmission pipeline or tunnel to convey the water to storage;

4. Storage reservoir to provide for winter carry-over and storage during rainy weather;

5. Irrigation systems similar to those used by farmers, and agricultural or open-space land;

6. Soil zone consisting of the upper one or two feet of the earth;

7. Underground drainage system which collects the percolating water from beneath the soil zone and transmits it to a natural or artificial channel;

8. Sludge disposal land and facilities which apply the settled solids to land at predetermined rates to increase the nutrient content of the soil and to provide a soil conditioner.

The Western Land Treatment Area utilizes the components listed above, including a Transmission Tunnel to convey wastewater and storm water runoff from the Cleveland metropolitan area to the western agricultural area. The 183-square mile western land treatment site lies in portions of Huron, Seneca, Crawford and Richland Counties and is illustrated in Figure IV-5.

The land treatment sites which lie in the upper basins of the Cuyahoga, Rocky and Chagrin Rivers require much smaller tracts of land, and generally lie close to the urban areas being served. Some of these land treatment sites are paired with aerated lagoons; others treat stormwater which requires only storage prior to land treatment.

The Akron plant is the only water-based treatment plant which discharges treated water directly to a natural watercourse and continues to operate during the entire program. This treatment plant will be expanded and modified to treat sewage to a level which will permit body contact sports

in the receiving water. The discharge from Akron into the Cuyahoga River will increase the flow of the river; this is beneficial during low-flow periods. Streamflow will also be augmented by the upstream land treatment facilities: winter wastewater will be released from storage during the summer when natural flows are at their lowest level, and when municipal withdrawals create the most impact. (Streamflow augmentation of the Cuyahoga River is also discussed in a special subsection at the conclusion of the Plan C description.)

Sludge disposal in Plan C will be accomplished primarily by incineration and application to agricultural land prior to 2000. By 2000, incineration will be phased out and sludge generated by the aerated lagoons will be piped to agricultural land. The sludge normally generated at the Lake Erie shoreline plants is removed at the Western Land Treatment Area in Plan C; therefore, there is no provision for sludge disposal on the strip-mined land in Southeast Ohio.

The following tables summarize the data for Plan C. Table IV-3 tabulates the volumes of municipal/industrial wastewater treated; Table IV-9 indicates the type of treatment by facility. Sludge volumes generated by municipal/industrial wastewater and the methods of sludge disposal are indicated in Tables IV-6 and IV-12 respectively. Treatment of storm runoff is described by drainage district in Table IV-16. The plan is illustrated in Figures IV-3, IV-4 and IV-5.

Plant site selection in Plan C was based upon regionalization of treatment sites. Two major objectives were consolidation or lower basin plants, and, in the upper basins, returning effluent to local streams

near the origin of the wastewater. The plan design specifies that lower basin collection points which presently discharge to Lake Erie, or near the Lake, will be collected in the Effluent Transmission Tunnel for regional final treatment. Akron was selected for water-based discharge to the Cuyahoga River to augment stream flow.

Major formulation constraints were imposed in Plan C which controlled the basin scheduling of the plan and affected the cost.

As now formulated in Plan C, the Western Land Treatment component would not be made operational early enough to achieve Level 1 standards by the required date. Therefore, all shoreline plants were required to use advanced water-based treatment to achieve Level 1 standards independently prior to land treatment initiation. Wastewater needs only secondary level treatment prior to land treatment; the land treatment alone completes the removal of constituents to the degree required by both Level 1 and Level 2 standards. Prior to 1985, Plan C is primarily a water-based plan, with a land treatment system added in 1985. An additional constraint dictated that heavy metals and total dissolved solids be removed at the industry in the same manner as for water-based treatment.

There were no additional conditions imposed on the plan: 1) Akron was to have a water-based discharge to the Cuyahoga River; 2) an equal amount of water was to be added to the Cuyahoga River to replace the effluent transported from the Southerly treatment plant to the Western Land Treatment Area. These added waters were to help flush the lower reaches of the river.

Western Land Treatment Area

At its ultimate capacity during the study period, in the year 2020, the Western Land Treatment Area will provide treatment for approximately 200,000 million gallons per year of municipal/industrial wastewater and an average volume of 40,000 million gallons per year of stormwater. These annual volumes together amount to approximately 736,000 acre-feet, which are given land treatment on a total net irrigated area of 118,000 acres at an average application rate of 75 inches per year.

Replacement of Cleveland Southerly's Discharge to Cuyahoga River

In Plan C, the Southerly Sewage Treatment Plant becomes a major point of discharge to the Transmission Tunnel to the Western Land Treatment Area; in the year 2020, it would contribute approximately 35 percent of the municipal/industrial wastewater being conveyed through the tunnel from eight load points along the Lake Erie Shoreline. This flow significantly affects the economies of scale realized at the Western Land Treatment Area.

This same flow also represents a potential factor for water quality control in the Cuyahoga River below the Southerly plant site. AWARE has determined, in preliminary studies, that anaerobic conditions will occur in the navigation channel during low-flow, high-temperature periods regardless of the quality of the water entering it from upstream. Trial runs have shown that the dissolved oxygen (DO) in the river will decrease as it passes through the navigation channel. In order to ensure a DO level of 4 mg/l in the navigation channel, either oxygen must be added directly to the water, or a high level of flow augmentation with high quality water must be provided. The AWARE investigations concluded that no modification of upstream water quality could maintain a DO level of 3 mg/l during critical low-flow periods, and that aeration of the channel would be the only possible alternative.

In order to determine whether transmission of Southerly's return flow away from the Cuyahoga River in Plan C would be cost-effective given the constraint of preventing critical low flows in the lower Cuyahoga, costs were estimated for replacing the discharge from Southerly with an equivalent volume of water from Lake Erie. The economy of scale gained by adding Southerly's flow to wastewater being treated at the Western Land Treatment Area results

in a substantial savings. The combined cost of bringing an equivalent volume of Lake Erie water to the Southerly Plant outfall and of treating the Southerly flow at the Western Land Treatment Area, would be less than the cost of treating the water in an advanced biological treatment plant at the Southerly site. The annual cost difference would be approximately $1 million.

Further control of pollution in the Cuyahoga River navigation channel would not be related to the Southerly plant flow, but to other factors, such as the collection and treatment of storm runoff, elimination of combined overflows, and the curbing of present industrial pollutant discharges.

Phosphorous Removal Requirements for Plans B and C

The International Agreement on Great Lakes Water Quality calls for early reductions of phosphate flow to Lake Erie. This effluent quality constraint, coupled with the requirement that time be allowed for early action programs to demonstrate the reliability of land treatment in northern Ohio, resulted in the substitution of advanced wastewater treatment plants for land treatment in Plan C as the means of achieving Level 1 Standards for the Cleveland metropolitan area. Construction of Level 1 plants has also been scheduled in Plans A and B for the 1975 - 1980 period. Table IV-9 indicates the eight plants which would be constructed to Level 1 Standards in Plan C before completion of the Transmission Tunnel in 1985.

There are seven additional plants in the upper reaches of the Three Rivers Basin which are larger than 1.0 MGD capacity by 1980 and to which the phosphate removal requirement might apply. These include: Medina County, New Medina, Liverpool, Ravenna, New Kent, Burton, and Chagrin Falls. Of these

seven plants Burton and New Medina will be early-action land treatment demonstration projects and phosphorous will be removed. For the remaining five plants, aerated lagoons are scheduled for construction by 1977 to meet appropriate secondary treatment effluent requirements. If the phosphate removal requirements were applied to these five plants prior to 1983, then it is probable that activated sludge processes would be substituted for the aerated lagoons because of the compatability of activated sludge plants with phosphate removal processes.* These activated sludge plants would then be utilized for secondary treatment throughout the study period for Plan C.

The same rationale as above for using activated sludge plants for secondary treatment prior to land treatment in Plan B applies to four upstream plants, including Ravenna, Liverpool, Medina County, and Chagrin Falls. In Plan B, Kent is a physical chemical plant, as in Plan A.

The changes which occur in their total annual costs as a result of proceeding to activated sludge treatment plants for the five plants in Plan C, and the four plants in Plan B, are presented in Table V-13.

The final design decisions made by the design engineers after project authorization will deal directly with the question of whether to use activated sludge plants or aerated lagoons for secondary treatment of wastewater prior to final treatment at all municipal land treatment facilities located in the upper reaches of the basin in Plans B and C.

*Unless land treatment of wastewater at these 5 plants was initiated earlier, in which case the phosphorous would be applied to the crops. At any rate, phosphorous removal equipment would be abandoned on these activated sludge plants by 1985.

EARLY-ACTION PROGRAMS FOR PLANS A, B, C

Specific early-action projects related to the finally-selected plan should be initiated as soon as possible in order to produce data before the first major phase of construction. The objectives of these projects should be to provide experience for refining and optimizing designs and for making future decisions concerning the overall wastewater management system as it develops. Producing firm data on the costs and effectiveness of wastewater management techniques proposed in these plans will require thorough monitoring programs to establish baseline environmental conditions and to record changes. Conducting early-action programs will also demonstrate the practicality and benefits of the advanced wastewater treatment systems and facilitate public review and participation.

More complete discussions of the early-action proposals related to their fields of technical responsibility are contained in the Phase III Reports of Havens and Emerson, Ltd. and Wright-McLaughlin Engineers. The projects listed below are summarized in a matrix showing their applicability to particular plans.

1. Urban Stormwater Runoff Treatment

   a. Water-based treatment of runoff from a separately-sewered, densely-populated area of mixed residential and commercial developments -- concrete basin storage with capacity optimized with the treatment plant

capacity -- monitor influent and effluent -- measure rainfall and runoff -- Level 1 and Level 2 treatment provided.

b. Water-based treatment of runoff from a separately-sewered, moderately-populated area not in a metropolitan urban environment (a sub-urban residential area such as a smaller outlying city in rural surroundings) -- earthen basin storage with treatment capacity to empty basin in 30 days -- quantity and quality monitoring as in (a) -- Level 1 or Level 2 treatment depending on demonstration process selected.

c. Land-based treatment of runoff from a typical downtown urban area as in (a) above.

d. Land-based treatment of runoff from a typical outlying residential area as in (b) above.

2. Advanced Municipal Wastewater Treatment Plants

a. Physical-chemical treatment - on a 5 to 10 MGD plant with Level 2 capability -- monitor cost of operation closely with efficiency -- make side stream studies to determine response to highly varying flow rates. (Investigation of treatment of mixed domestic-industrial waste in a larger size plant could also be considered.)

b. Biological treatment - Level 1 and Level 2 capability

-- monitor plant influent and effluent as well as river above and below the plant effluent. Monitor river for chemical and biological quality to assess benefits of higher degrees of treatment -- for large municipality with mixed municipal, industrial and stormwater flow as well as for smaller size plants.

c. Land treatment - (1) at an in-basin site using the overland flow/infiltration method -- (2) at an in-basin site using the spray irrigation method on Chili Soils -- (3) at a site in the western land treatment area using the center-pivot rig spray irrigation method on Cardington-Bennington Soils - with various land management techniques.

3. Storm Runoff Reduction by Urban Drainage Management

Provide storm drains, on-site storage, parking-lot storage, roof-top storage, and site work designed for maximum infiltration -- demonstrate techniques to reduce runoff -- sedimentation control practices to be demonstrated -- Planned Unit Development Concept applied to demonstration site -- use a commercial building block in a major city -- use open space in a major city suburb.

4. Sludge Handling

Show various ways to handle sludge -- apply to agricultural land, strip-mined land, and sanitary landfill --

monitor leacheate and surface runoff for loss of metals, salts, nutrients, and viruses -- compare crop yields and physical characteristics using conditioned soil with crops from non-conditioned soil -- study sludge application techniques, including injection and costs -- study problems posed by wintertime conditions -- use a mixed municipal-industrial sludge to measure heavy metal disposal capabilities of soil in agricultural land area -- demonstrate reclamation potential in strip-mined lands and other sterile areas.

5. Water Quality and Quantity Monitoring System

Master system for entire Three Rivers Basin Study Area -- computerized control center for water intelligence.

Program	Plan A	Plan B	Plan C
1. Urban Stormwater Runoff Treatment			
a.	X	X	X
b.	X	X	X
c.		X	X
2. Advanced Municipal Wastewater Treatment			
a.	X	X	
b.	X	X	
c.			
(1)		X	X
(2)		X	X
(3)			X
3. Storm Runoff Reduction by Urban Drainage Management	X	X	X
4. Sludge Handling	X	X	X
5. Water Quality and Quantity Monitoring System	X	X	X

TABLE IV-1

MUNICIPAL/INDUSTRIAL WASTEWATER TREATED BY DECADE — PLAN A

(MGD)

PLANT	1972	1980	1990	2000	2010	2020
Lake Erie						
Cleveland Easterly	125.00	140.00	148.00	158.00	164.00	172.00
Cleveland Westerly	35.91	37.14	39.69	41.22	42.75	45.18
Euclid	14.53	19.11	24.05	28.60	33.63	37.34
Rocky River	7.14	11.11	14.39	16.77	19.72	22.05
Total	182.58	207.36	226.13	244.59	260.10	276.57
Rocky River Basin						
Lakewood	17.11	18.00	19.00	19.00	20.00	21.00
Liverpool	3.08	6.69	9.40	12.24	15.85	20.09
Total	20.19	24.69	28.40	31.24	35.85	41.09
Cuyahoga River Basin						
Akron	71.00	84.09	97.83	111.33	129.03	149.67
Auburn Township	0.17	0.28	0.39	0.53	0.69	0.84
Burton	0.18	0.32	0.45	0.56	0.72	0.91
Butternut Creek	0.24	0.37	0.50	0.66	0.89	1.17
*Chardon	0.03	0.07	0.10	0.13	0.17	0.20
Cleveland Southerly	101.65	129.24	182.52	206.15	225.21	234.20
East Claridon	0.08	0.14	0.21	0.31	0.39	0.48
Kent	5.83	10.68	15.93	20.15	24.65	28.41
Mantua	0.29	0.37	0.47	0.58	0.74	0.86
Middlefield	0.77	1.06	1.42	1.72	2.23	2.70
Randolph	0.20	0.30	0.40	0.50	0.65	0.75
Ravenna	2.05	3.35	5.41	8.53	10.60	12.34
Troy Township	0.09	0.15	0.21	0.29	0.38	0.47
Total	182.58	230.42	305.84	351.44	396.35	433.00
Chagrin River Basin						
Aurora Central	0.22	0.60	1.32	1.73	2.31	2.98
Chagrin E. Branch	0.49	0.72	1.00	1.25	1.58	1.95
Chagrin Fall	0.81	1.35	2.05	2.53	3.08	3.58
Fairmount Road	0.07	0.54	1.55	2.14	2.80	3.40
Fowler's Mill	0.42	0.64	0.88	1.14	1.54	1.98
McFarland Creek	0.18	0.63	1.90	2.66	3.52	4.29
Newbury Township	0.33	0.50	0.69	0.90	1.13	1.54
Willoughby-Eastlake	5.55	7.92	11.61	15.07	18.96	22.27
Total	8.07	12.90	21.00	27.42	34.92	41.99
Interim Plants	20.10	21.21				
Grand Total	413.52	496.58	581.37	654.69	727.22	792.65

* Chardon is treated out of the Study Area and is not costed in this plan.

TABLE IV-2

MUNICIPAL/INDUSTRIAL WASTEWATER TREATED BY DECADE

PLAN B

(MGD)

PLANT	1972	1980	1990	2000	2010	2020
Lake Erie						
Cleveland Easterly	125.00	140.00	148.00	158.00	164.00	172.00
Cleveland Westerly	35.91	37.14	39.69	41.22	42.75	45.18
Euclid	14.53	19.11	24.05	28.60	33.63	37.34
Rocky River	7.14	11.11	14.39	16.77	19.72	22.05
Total	182.58	207.36	226.13	244.59	260.10	276.57
Rocky River Basin						
Hinckley	0.12	0.55	1.04	1.25	1.50	1.72
Lakewood	17.11	18.00	19.00	19.00	20.00	21.00
Liverpool	0.41	1.31	1.96	2.57	3.41	5.00
Mallet Creek	0.10	0.20	0.30	0.40	0.50	0.60
Medina County	0.41	1.31	1.96	2.57	3.41	5.00
New Medina	2.16	3.87	5.18	6.70	8.53	9.49
Upper East Branch	0.08	0.36	0.68	0.81	0.96	1.11
Total	20.39	25.60	30.12	33.30	38.31	43.92
Cuyahoga River Basin						
Akron	71.00	84.09	97.83	111.33	129.03	149.67
Auburn Township	0.17	0.28	0.39	0.53	0.69	0.84
Burton	0.95	1.38	1.87	2.28	2.95	3.61
Butternut Creek	0.24	0.37	0.50	0.66	0.89	1.17
Chardon	0.03	0.07	0.10	0.13	0.17	0.20
Cleveland Southerly	101.65	128.33	179.68	202.67	221.02	229.37
East Claridon	0.08	0.14	0.21	0.31	0.39	0.48
Mantua	0.29	0.37	0.47	0.58	0.74	0.86
New Kent	5.83	10.68	15.93	20.15	24.65	28.41
Randolph	0.20	0.30	0.40	0.50	0.65	0.75
Ravenna	2.05	3.35	5.41	8.53	10.60	12.34
Shalersboro	0.59	0.84	1.12	1.42	1.73	2.00
Troy Township	0.09	0.15	0.21	0.29	0.38	0.47
Total	183.17	230.35	304.12	349.38	393.89	430.17
Chagrin River Basin						
Aurora Central	0.22	0.60	1.32	1.73	2.31	2.98
Chagrin E. Branch	0.49	0.72	1.00	1.25	1.58	1.95
Chagrin Falls	0.99	1.98	3.95	5.19	6.60	7.87
Fairmount Road	0.07	0.54	1.55	2.14	2.80	3.40
Fowler's Mill	0.42	0.64	0.88	1.14	1.54	1.98
Newbury Township	0.33	0.50	0.69	0.90	1.13	1.54
Willoughby-Eastlake	5.55	7.92	11.61	15.07	18.96	22.27
Total	8.07	12.90	21.00	27.42	34.92	41.99
Interim Plants	19.31	20.37				
Grand Total	413.52	496.58	581.37	654.69	727.22	792.65

TABLE IV-3

MUNICIPAL/INDUSTRIAL WASTEWATER TREATED BY DECADE

PLAN C

(MGD)

PLANT	1972	1980	1990	2000	2010	2020
Western Land Treatment Area			94.12	481.33	520.09	549.21
Transmission Tunnel						
Euclid	14.53	19.11	(24.05)	(28.60)	(33.63)	(37.34)
Lakewood	17.11	18.00	(19.00)	(19.00)	(20.00)	(21.00)
North Olmsted	5.24	18.84	(25.07)	(29.77)	(34.23)	(37.00)
Rocky River	7.14	11.11	(14.39)	(16.77)	(19.72)	(22.05)
Willoughby-Eastlake	5.55	7.92	(11.61)	(15.07)	(18.96)	(22.27)
Easterly	125.00	140.00	148.00	(158.00)	(164.00)	(172.00)
Southerly	101.65	118.23	154.61	(172.90)	(186.79)	(192.37)
Westerly	35.91	37.14	39.69	(41.22)	(42.75)	(45.18)
Total	312.13	370.36	342.30	(All flows to Western Land Treatment Area)		
Rocky River In-Basin						
Hinckley	0.12	0.55	1.04	1.25	1.50	1.72
Liverpool	0.41	1.31	1.96	2.57	3.41	5.00
Mallet Creek	0.10	0.20	0.30	0.40	0.50	0.60
Medina County	0.41	1.31	1.96	2.57	3.41	5.00
New Medina	2.16	3.87	5.18	6.70	8.53	9.49
Upper East Branch	0.08	0.36	0.68	0.81	0.96	1.11
Total	3.28	7.60	11.12	14.30	18.31	22.92
Cuyahoga River In-Basin						
Akron	71.00	84.09	97.83	111.33	129.03	149.67
Auburn Township	0.17	0.28	0.39	0.53	0.69	0.84
Burton	0.95	1.38	1.87	2.28	2.95	3.61
Butternut Creek	0.24	0.37	0.50	0.66	0.89	1.17
Chardon	0.03	0.07	0.10	0.13	0.17	0.20
East Claridon	0.08	0.14	0.21	0.31	0.39	0.48
Mantua	0.29	0.37	0.47	0.58	0.74	0.86
New Kent	5.83	10.68	15.93	20.15	24.65	28.41
Randolph	0.20	0.30	0.40	0.50	0.65	0.75
Ravenna	2.05	3.35	5.41	8.53	10.60	12.34
Shalersboro	0.59	0.84	1.12	1.42	1.73	2.00
Troy Township	0.09	0.15	0.21	0.29	0.38	0.47
Total	81.52	102.02	124.44	146.71	172.87	200.80
Chagrin In-Basin						
Aurora Central	0.22	0.60	1.32	1.73	2.31	2.98
Chagrin East Branch	0.49	0.72	1.00	1.25	1.58	1.95
Chagrin Falls	0.99	1.98	3.95	5.19	6.60	7.87
Fairmount Road	0.07	0.54	1.55	2.14	2.80	3.40
Fowler's Mill	0.42	0.64	0.88	1.14	1.54	1.98
Newbury Township	0.33	0.50	0.69	0.90	1.13	1.54
Total	2.52	4.98	9.39	12.35	15.96	19.72
Interim Plants	14.07	11.63				
Grand Total	413.52	496.58	581.37	654.69	727.22	792.65

TABLE IV-4

SLUDGE VOLUMES FOR DISPOSAL

(Dry Tons Per Day - DT/Day)

PLAN A

PLANT	1972	1980	1990	2000	2010	2020
Lake Erie						
Cleveland Easterly	84.80	94.98	107.98	115.28	119.65	125.49
Cleveland Westerly	30.88	31.94	34.13	35.45	36.76	38.85
Euclid	9.86	12.96	17.55	20.87	24.54	27.24
Rocky River	3.20	4.98	6.45	7.51	8.83	9.88
Total	128.74	144.86	166.11	179.11	189.78	201.46
Rocky River Basin						
Lakewood	11.61	12.21	13.86	13.86	14.59	15.32
Liverpool	2.09	4.54	6.86	8.93	11.56	14.66
Total	13.70	16.75	20.72	22.79	26.15	29.98
Cuyahoga River Basin						
Akron	48.17	57.05	71.38	81.23	94.14	109.20
Auburn Township	0.12	0.19	0.28	0.39	0.50	0.61
Burton	0.12	0.22	0.33	0.41	0.53	0.67
Butternut Creek	0.16	0.25	0.36	0.48	0.65	0.85
Cleveland Southerly	68.96	87.68	133.17	150.41	164.31	170.87
East Claridon	0.05	0.09	0.15	0.23	0.28	0.35
Mantua	0.20	0.25	0.34	0.42	0.54	0.63
Middlefield	0.52	0.72	1.04	1.25	1.63	1.97
New Kent	5.01	9.18	13.70	17.33	21.20	24.43
Randolph	0.14	0.20	0.29	0.36	0.47	0.55
Ravenna	1.39	2.27	3.95	6.22	7.73	9.CO
Troy Township	0.06	0.10	0.15	0.21	0.28	0.34
*Total	124.90	158.20	225.14	258.94	292.26	319.47
Chagrin River Basin						
Aurora Central	0.15	0.41	0.96	1.26	1.69	2.17
Chagrin E. Branch	0.33	0.49	0.73	0.91	1.15	1.42
Chagrin Falls	0.55	0.91	1.49	1.84	2.25	2.61
Fairmount Road	0.05	0.37	1.13	1.56	2.04	2.48
Fowler's Mill	0.28	0.43	0.64	0.83	1.12	1.44
McFarland Creek	0.12	0.43	1.39	1.94	2.57	3.13
Newbury Township	0.22	0.34	0.50	0.66	0.82	1.12
Willoughby-Eastlake	2.29	5.37	8.47	11.00	13.83	16.25
Total	3.99	8.75	15.31	20.00	25.47	30.62
Grand Total	271.33	328.56	427.28	480.84	533.66	581.53

*No sludge is generated by Chardon within the Study Area.

TABLE IV-5

SLUDGE VOLUMES FOR DISPOSAL — PLAN B

(Dry Tons Per Day - DT/Day)

PLANT	1977	1980	1990	2000	2010	2020
Lake Erie						
Cleveland Easterly	91.93	94.98	107.98	115.28	119.65	125.49
Cleveland Westerly	31.62	31.94	34.13	35.45	36.76	38.85
Euclid	12.03	12.96	17.55	20.87	24.54	27.24
Rocky River	4.45	4.98	6.45	7.51	8.83	9.88
Total	140.03	144.86	166.11	179.11	189.78	201.46
Rocky River Basin						
Hinckley	0.09	0.12	0.20	0.26	0.32	0.36
Lakewood	12.03	12.21	13.86	13.86	14.59	15.32
Liverpool	0.22	0.28	0.41	0.54	0.72	1.05
Mallet Creek	0.04	0.04	0.06	0.08	0.11	0.13
Medina County	0.22	0.28	0.41	0.53	0.72	1.05
New Medina	0.51	0.61	0.85	1.10	1.44	1.99
Upper East Branch	0.06	0.08	0.14	0.17	0.20	0.23
Total	13.17	13.62	15.93	16.54	18.10	20.13
Cuyahoga River Basin						
Akron	54.39	57.05	71.38	81.23	94.14	109.20
Auburn Township	0.05	0.06	0.08	0.11	0.15	0.18
Burton	0.26	0.29	0.40	0.48	0.62	0.76
Butternut Creek	0.07	0.08	0.11	0.14	0.19	0.25
Chardon	--	0.01	0.02	0.03	0.04	0.04
Cleveland Southerly	81.63	87.06	131.09	147.87	161.26	167.35
East Claridon	0.03	0.03	0.04	0.07	0.08	0.10
Mantua	0.07	0.08	0.11	0.12	0.16	0.18
New Kent	7.93	9.18	13.70	17.33	21.20	24.43
Randolph	0.06	0.06	0.08	0.11	0.14	0.16
Ravenna	0.62	0.70	1.14	1.80	2.23	2.59
Shalersboro	0.16	0.18	0.24	0.30	0.36	0.42
Troy Township	--	0.03	0.04	0.06	0.08	0.10
Total	145.27	154.81	218.43	249.65	280.65	305.76
Chagrin River Basin						
Aurora Central	0.10	0.13	0.28	0.36	0.49	0.63
Chagrin E. Branch	0.14	0.15	0.21	0.26	0.33	0.41
Chagrin Falls	0.35	0.42	0.82	1.09	1.39	1.65
Fairmount Road	0.08	0.11	0.33	0.45	0.59	0.71
Fowler's Mill	0.12	0.13	0.19	0.24	0.32	0.42
Newbury Township	0.09	0.10	0.15	0.19	0.24	0.32
Willoughby-Eastlake	4.89	5.37	8.47	11.00	13.83	16.25
Total	5.77	6.41	10.45	13.59	17.19	20.39
Grand Total	304.24	319.70	410.92	458.89	505.72	547.74

TABLE IV-6

SLUDGE VOLUMES FOR DISPOSAL — PLAN C

(Dry Tons Per Day - DT/Day)

PLANT	1977	1980	1990	2000	2010	2020
Western Land Treatment Area	--	--	36.88	101.08	109.22	115.33
Lake Erie Shoreline Plants						
Euclid	12.04	12.96	--	--	--	--
Lakewood	12.03	12.21	--	--	--	--
North Olmsted	10.01	12.78	--	--	--	--
Rocky River	4.44	4.98	--	--	--	--
Willoughby-Eastlake	4.88	5.37	--	--	--	--
Easterly	(Incinerated through 1999)			--	--	--
Southerly	(Incinerated through 1999)			--	--	--
Westerly	(Incinerated through 1999)			--	--	--
Total	43.40	48.30	--	--	--	--
Rocky River Basin						
Hinckley	0.09	0.12	0.20	0.26	0.32	0.36
Liverpool	0.22	0.28	0.41	0.54	0.72	1.05
Mallet Creek	0.04	0.04	0.06	0.08	0.11	0.13
Medina County	0.22	0.28	0.41	0.53	0.72	1.05
New Medina	0.63	0.81	1.09	1.41	1.79	1.99
Upper East Branch	0.06	0.08	0.14	0.17	0.20	0.23
Total	1.26	1.61	2.31	2.99	3.86	4.81
Cuyahoga River Basin						
Akron	54.39	57.05	71.38	81.23	94.14	109.20
Auburn Township	0.05	0.06	0.08	0.11	0.15	0.18
Burton	0.26	0.29	0.40	0.48	0.62	0.76
Butternut Creek	0.07	0.08	0.11	0.14	0.19	0.25
Chardon	--	0.01	0.02	0.03	0.04	0.04
East Claridon	0.03	0.03	0.04	0.07	0.08	0.10
Mantua	0.07	0.08	0.11	0.12	0.16	0.18
New Kent	1.94	2.25	3.35	4.24	5.18	5.97
Randolph	0.06	0.06	0.08	0.11	0.14	0.16
Ravenna	0.62	0.70	1.14	1.80	2.23	2.59
Shalersboro	0.16	0.18	0.24	0.30	0.36	0.42
Troy Township	--	0.03	0.04	0.06	0.08	0.10
Total	57.65	60.82	76.99	88.69	103.37	119.95
Chagrin River Basin						
Aurora Central	0.10	0.13	0.28	0.36	0.49	0.63
Chagrin East Branch	0.14	0.15	0.21	0.26	0.33	0.41
Chagrin Falls	0.35	0.42	0.82	1.09	1.39	1.65
Fairmount Road	0.08	0.11	0.33	0.45	0.59	0.71
Fowler's Mill	0.12	0.13	0.19	0.24	0.32	0.42
Newbury Township	0.09	0.10	0.15	0.19	0.24	0.32
Total	0.88	1.04	1.98	2.59	3.36	4.14
Grand Total	103.19	111.77	118.16	195.35	219.81	244.23

TABLE IV-7

MUNICIPAL/INDUSTRIAL TREATMENT FACILITIES

PLAN A

1977	1980	1985	2020
s rds.		Advanced biological treatment plants are upgraded to meet Level 2 standards.	Treatment plants are expanded as necessary.
t nd		Treatment plant is expanded as necessary.	
d t		Physical-chemical treatment component is upgraded to meet Level 2 standards.	Treatment plant is expanded as necessary.
		Advanced biological treatment plant is upgraded to meet Level 2 standards.	Treatment plant is expanded as necessary.
lant dards.	Treatment plant is upgraded to meet Level 2 standards.		Treatment plant is expanded as necessary.
rds.		Advanced biological treatment plants are upgraded to meet Level 2 standards.	Treatment plants are expanded as necessary.
it is ds.	Treatment plant is upgraded to meet Level 2 standards.		Treatment plant is expanded as necessary.
ants ndards re-	Treatment plants are upgraded to meet Level 2 standards.		Treatment plants are expanded as necessary.
onstructed to transmit the sewage to a treatment plant outside the Study Area.			
lants ndards.	Treatment plants are upgraded to meet Level 2 standards.		Treatment plants are expanded as necessary.
is upgraded to		Advanced biological treatment plant is upgraded to meet Level 2 standards.	Treatment plant is expanded as necessary.

TABLE IV-7

MUNICIPAL/INDUSTRIAL TREATMENT FACILITIES

	1972	1977	1980
Lake Erie Basin			
Cleveland Easterly Euclid	Existing biological treatment plants are upgraded to meet Level 1 standards.		Advanced biological treatment plants are upgraded to meet Level 2 standards.
Cleveland Westerly	Existing physical-chemical treatment plant is upgraded to meet Level 1 and 2 standards.		Treatment plant is expanded as necessary
Rocky River	Physical-chemical component is added to the existing biological treatment plant to meet Level 1 standards.		Physical-chemical treatment component is upgraded to meet Level 2 standards.
Rocky River Basin			
Lakewood	Existing biological treatment plant is upgraded to meet Level 1 standards.		Advanced biological treatment plant is upgraded to meet Level 2 standards.
Liverpool	New advanced biological treatment plant is constructed to meet Level 1 standards.	Treatment plant is upgraded to meet Level 2 standards.	
Cuyahoga River Basin			
Akron Cleveland Southerly Ravenna	Existing biological treatment plants are upgraded to meet Level 1 standards.		Advanced biological treatment plants are upgraded to meet Level 2 standards.
New Kent	New physical-chemical treatment plant is constructed to meet Level 1 standards.	Treatment plant is upgraded to meet Level 2 standards.	
Auburn Township Burton Butternut Creek East Claridon Mantua Middlefield Randolph Troy Township	New advanced biological treatment plants are constructed to meet Level 1 standards and to satisfy secondary treatment requirement by 1977.	Treatment plants are upgraded to meet Level 2 standards.	
Chardon	A pumping plant and force main are constructed to transmit the sewage to a treatment plant outside th		
Chagrin River Basin			
Aurora Central Chagrin East Branch Chagrin Falls Fairmount Road Fowler's Mill McFarland Creek Newbury Township	New advanced biological treatment plants are constructed to meet Level 1 standards.	Treatment plants are upgraded to meet Level 2 standards.	
Willoughby-Eastlake	Existing biological treatment plant is upgraded to meet Level 1 standards.		Advanced biological treatment plant is upgraded to meet Level 2 standards.

TABLE IV-7

MUNICIPAL/INDUSTRIAL TREATMENT FACILITIES

PLAN A

1977	1980	1985	2020
nts dards.		Advanced biological treatment plants are upgraded to meet Level 2 standards.	Treatment plants are expanded as necessary.
ent and		Treatment plant is expanded as necessary.	
ded ent		Physical-chemical treatment component is upgraded to meet Level 2 standards.	Treatment plant is expanded as necessary.
nt dards.		Advanced biological treatment plant is upgraded to meet Level 2 standards.	Treatment plant is expanded as necessary.
t plant tandards.	Treatment plant is upgraded to meet Level 2 standards.		Treatment plant is expanded as necessary.
nts dards.		Advanced biological treatment plants are upgraded to meet Level 2 standards.	Treatment plants are expanded as necessary.
lant is dards.	Treatment plant is upgraded to meet Level 2 standards.		Treatment plant is expanded as necessary.
t plants tandards t re-	Treatment plants are upgraded to meet Level 2 standards.		Treatment plants are expanded as necessary.
e constructed to transmit the sewage to a treatment plant outside the Study Area.			
t plants tandards.	Treatment plants are upgraded to meet Level 2 standards.		Treatment plants are expanded as necessary.
nt is upgraded to		Advanced biological treatment plant is upgraded to meet Level 2 standards.	Treatment plant is expanded as necessary.

TABLE IV-8

MUNICIPAL/INDUSTRIAL TREATMENT FACILITIES

	1972	1977	1980	1983	1985
Lake Erie Basin					
Cleveland Easterly Euclid	Existing biological treatment plants are upgraded to meet Level 1 standards.			Advanced biological treatment plants are upgraded to meet Level 2 standards.	
Cleveland Westerly	Existing physical-chemical treatment plant is upgraded to meet Level 1 and 2 standards.			Treatment plant is expanded as necessary.	
Rocky River	Physical-chemical component is added to the existing biological treatment plant to meet Level 1 standards.			Physical-chemical treatment component is upgraded to meet Level 2 standards.	
Rocky River Basin					
Lakewood	Existing biological treatment plant is upgraded to meet Level 1 standards.			Advanced biological treatment plant is upgraded to meet Level 2 standards.	
Hinckley Liverpool Mallet Creek Medina County New Medina Upper East Branch	Existing treatment facilities are phased out and aerated lagoons are constructed by 1977 to satisfy secondary treatment requirements.		Aerated lagoons are operated to provide secondary treatment. Winter reservoirs and land treatment sites are constructed by 1983 to meet Level 2 standards.		Land treatment facilit
Cuyahoga River Basin					
Akron Cleveland Southerly	Existing biological treatment plants are upgraded to meet Level 1 standards.			Advanced biological treatment plants are upgraded to meet Level 2 standards.	
New Kent	New physical-chemical treatment plant is constructed to meet Level 1 standards.		Treatment plant is upgraded to meet Level 2 standards.		
Auburn Township Burton Butternut Creek Chardon East Claridon Mantua Randolph Ravenna Shalersboro Troy Township	Existing treatment facilities are phased out and aerated lagoons are constructed by 1977 to satisfy secondary treatment requirements.		Aerated lagoons are operated to provide secondary treatment. Winter reservoirs and land treatment sites are constructed by 1983 to meet Level 2 standards.		Land treatment facilit
Chagrin River Basin					
Aurora Central Chagrin E. Branch Chagrin Falls Fairmount Road Fowler's Mill Newbury Township	Existing treatment facilities are phased out and aerated lagoons are constructed by 1977 to satisfy secondary treatment requirements.		Aerated lagoons are operated to provide secondary treatment. Winter reservoirs and land treatment sites are constructed by 1983 to meet Level 2 standards.		Land treatment facilit
Willoughby-Eastlake	Existing biological treatment plant is upgraded to meet Level 1 standards.			Advanced biological treatment plant is upgraded to meet Level 2 standards.	

TABLE IV-8

MUNICIPAL/INDUSTRIAL TREATMENT FACILITIES

PLAN B

1977	1980	1983	1985	2020
cal treatment plants are upgraded to ndards.		Advanced biological treatment plants are upgraded to meet Level 2 standards.		Treatment plants are expanded as necessary.
l-chemical treatment plant is up- evel 1 and 2 standards.		Treatment plant is expanded as necessary.		
l component is added to the existing ent plant to meet Level 1 standards.		Physical-chemical treatment component is upgraded to meet Level 2 standards.		Treatment plant is expanded as necessary.
cal treatment plant is upgraded to ndards.		Advanced biological treatment plant is upgraded to meet Level 2 standards.		Treatment plant is expanded as necessary.
nt facilities are erated lagoons are 977 to satisfy ent requirements.	Aerated lagoons are operated to provide secondary treatment. Winter reservoirs and land treatment sites are constructed by 1983 to meet Level 2 standards.		Land treatment facilities are expanded as necessary.	
cal treatment plants are Level 1 standards.		Advanced biological treatment plants are upgraded to meet Level 2 standards.		Treatment plants are expanded as necessary.
ical treatment plant is et Level 1 standards.	Treatment plant is upgraded to meet Level 2 standards.			Treatment plant is expanded as necessary.
nt facilities are erated lagoons are 977 to satisfy ent requirements.	Aerated lagoons are operated to provide secondary treatment. Winter reservoirs and land treatment sites are constructed by 1983 to meet Level 2 standards.		Land treatment facilities are expanded as necessary.	
nt facilities are erated lagoons are 977 to satisfy ent requirements.	Aerated lagoons are operated to provide secondary treatment. Winter reservoirs and land treatment sites are constructed by 1983 to meet Level 2 standards.		Land treatment facilities are expanded as necessary.	
al treatment plant is upgraded to dards.		Advanced biological treatment plant is upgraded to meet Level 2 standards.		Treatment plant is expanded as necessary.

TABLE IV-9

MUNICIPAL/INDUSTRIAL TREATMENT FACILITIES

	1972	1977	1980	1983	1985	1990
Western Land Treatment Area	Transmission tunnel, winter storage reservoir and land treatment site are constructed by 1985 to meet Level 2 standards.				Secondary effluent transported by the tunnel is provided storage and land treatment. The aerated lagoon is constructed by 1990.	
Transmission Tunnel						
Euclid STP (Tunnel Inlet) Lakewood STP (Tun Inlet) North Omsted STP (Tunnel Inlet) Rocky River STP (Tunnel Inlet) Willoughby-Eastlake STP (Tunnel Inlet)	Existing treatment plants are upgraded to meet Level 1 standards. New construction and replacement of facilities are sized to be phased out in 1990.			Treatment plants provide Level 1 treatment and are expanded as necessary.	Treatment plants are downgraded to provide secondary treatment. Effluent is discharged to tunnel and receives land treatment to meet Level 2 standards.	
Easterly STP (Tunnel Inlet) Southerly STP (Tunnel Inlet) Westerly STP (Tunnel Inlet)	Existing treatment plants are upgraded to meet Level 1 standards. New construction and replacement of facilities are sized to be phased out in 2000.			Treatment plants provide Level 1 treatment and are expanded as necessary.	Treatment plants are downgraded to provide secondary treatment. Effluent is discharged to tunnel and receives land treatment to meet Level 2 standards.	
Rocky River In-Basin						
Hinckley Liverpool Mallet Creek Medina County New Medina Upper East Branch	Existing treatment facilities are phased out and aerated lagoons are constructed by 1977 to satisfy secondary treatment requirements.		Aerated lagoons are operated to provide secondary treatment. Winter reservoirs and land treatment sites are constructed by 1983 to meet Level 2 standards.		Land treatment facilities are expanded	
Cuyahoga River In-Basin						
Akron	Existing biological treatment plant is upgraded to meet Level 1 standards.			Advanced biological treatment plant is upgraded to meet Level 2 standards.		Treatment plant is e
Auburn Township Burton Butternut Creek Chardon East Claridon Mantua New Kent Randolph Ravenna Shalersboro Troy Township	Existing treatment facilities are phased out and aerated lagoons are constructed by 1977 to satisfy secondary treatment requirements.		Aerated lagoons are operated to provide secondary treatment. Winter reservoirs and land treatment sites are constructed by 1983 to meet Level 2 standards.		Land treatment facilities are expanded a	
Chagrin River In-Basin						
Aurora Central Chagrin E. Branch Chagrin Falls Fairmount Road Fowler's Mill Newbury Township	Existing treatment facilities are phased out and aerated lagoons are constructed by 1977 to satisfy secondary treatment requirements.		Aerated lagoons are operated to provide secondary treatment. Winter reservoirs and land treatment sites are constructed by 1983 to meet Level 2 standards.		Land treatment facilities are expanded a	

TABLE IV-9

MUNICIPAL/INDUSTRIAL TREATMENT FACILITIES

PLAN C

1980	1983	1985	1990	2000	2020
rage reservoir and land treatment site Level 2 standards.		Secondary effluent transported by the tunnel is provided storage and land treatment. The aerated lagoon is constructed by 1990.	Aerated lagoon and land application provide both secondary and final treatment at the Western Land Treatment Area.		
pgraded construc- ties are	Treatment plants provide Level 1 treatment and are expanded as necessary.	Treatment plants are downgraded to provide secondary treatment. Effluent is discharged to tunnel and receives land treatment to meet Level 2 standards.	Treatment plants are phased out in 1990 and only preliminary treatment is provided at tunnel inlets. Aerated lagoon and land application provide both secondary and final treatment at Western Land Treatment Area.		
pgraded construc- ties are	Treatment plants provide Level 1 treatment and are expanded as necessary.	Treatment plants are downgraded to provide secondary treatment. Effluent is discharged to tunnel and receives land treatment to meet Level 2 standards.	Period of redundancy with secondary treatment provided both at treatment plants and at aerated lagoon.	Treatment plants are phased out in 2000 and only preliminary treatment is provided at tunnel inlets. Aerated lagoon and land application provide both secondary and final treatment at Western Land Treatment Area.	
ed lagoons are operated to de secondary treatment. r reservoirs and land treat- sites are constructed by to meet Level 2 standards.	Land treatment facilities are expanded as necessary.				
plant is ards.	Advanced biological treatment plant is upgraded to meet Level 2 standards.	Treatment plant is expanded as necessary.			
goons are operated to condary treatment. Winter and land treatment sites ucted by 1983 to meet andards.	Land treatment facilities are expanded as necessary.				
goons are operated to condary treatment. Winter and land treatment sites ucted by 1983 to meet andards.	Land treatment facilities are expanded as necessary.				

TABLE IV-10

SLUDGE DISPOSAL

	1972	1977	1990
Lake Erie			
Cleveland Easterly	Sludge will be piped to Cleveland Southerly for incineration.		Sludge will be
Cleveland Westerly	Sludge will be incinerated.		
Euclid	Sludge will be vacuum-filtered and trucked to agricultural land.		Sludge will be
Rocky River (primary)	Sludge will be vacuum-filtered and trucked to agricultural land.		Sludge from Ro sent via pipel
Rocky River Basin			
Lakewood	Sludge will be flash dried and will be trucked to agricultural land.		Sludge from Ro sent via pipel
Liverpool	Sludge handling from existing facilities will be phased out by 1977.	Sludge will be sent via pipeline to agricultural la	
Cuyahoga River Basin*			
Akron	Sludge will be vacuum-filtered and trucked to agricultural land.		Sludge will be
Cleveland Southerly	Sludge will be incinerated.		
Ravenna	Sludge will be sent via the existing pipeline to strip-mined land.		
New Kent	Sludge will be incinerated.		
Auburn Township Burton Butternut Creek Mantua Middlefield Randolph	Sludge handling from existing facilities will be phased out by 1977.	Liquid sludge will be trucked to adjacent agricultu	
East Claridon Troy Township	Sludge handling from existing facilities will be phased out by 1977.	Sludge will be dried in sand drying beds and will b	
Chagrin River Basin			
Aurora Central Chagrin E. Branch Chagrin Falls Fairmount Road Fowler's Mill McFarland Creek Newbury Township	Sludge handling from existing facilities will be phased out by 1977.	Liquid sludge will be trucked to adjacent agricultu	
Willoughby-Eastlake	Sludge will be sent via the existing pipeline to strip-mined land.		Sludge will be

*No sludge disposal from Chardon.

TABLE IV-10

SLUDGE DISPOSAL — PLAN A

1977	1990	2020
o Cleveland Southerly for incineration.		Sludge will be sent via new pipeline to strip-mined land.
ated.		
filtered and trucked to agricultural land.		Sludge will be sent via new pipeline to strip-mined land.
filtered and trucked to agricultural land.		Sludge from Rocky River (primary) and Lakewood will be sent via pipeline to agricultural land.
ried and will be trucked to agricultural land.		Sludge from Rocky River (primary) and Lakewood will be sent via pipeline to agricultural land.
xisting facilities 1977.	Sludge will be sent via pipeline to agricultural land.	
filtered and trucked to agricultural land.		Sludge will be sent via new pipeline to strip-mined land.
ated.		
a the existing pipeline to strip-mined land.		
ated.		
xisting facilities 1977.	Liquid sludge will be trucked to adjacent agricultural land.	
xisting facilities 1977.	Sludge will be dried in sand drying beds and will be trucked to adjacent agricultural land.	
xisting facilities 1977.	Liquid sludge will be trucked to adjacent agricultural land.	
a the existing pipeline to strip-mined land.		Sludge will be sent via pipeline to agricultural land.

2

TABLE-IV-11

SLUDGE DISPOSAL

	1972	1977	1990
Lake Erie			
Cleveland Easterly	Sludge will be piped to Cleveland Southerly for incineration.		Sludge will be sent
Cleveland Westerly	Sludge will be incinerated.		
Euclid	Sludge will be vacuum-filtered and trucked to agricultural land.		Sludge will be sent
Rocky River (primary)	Sludge will be vacuum-filtered and trucked to agricultural land.		Sludge from Rocky R sent via pipeline t
Rocky River Basin			
Lakewood	Sludge will be flash dried and will be trucked to agricultural land.		Sludge from Rocky R sent via pipeline t
Hinckley Liverpool Mallet Creek Medina County New Medina Upper East Branch	Sludge handling from existing facilities will be phased out by 1977.	Sludge removed from aerated lagoons will be piped to adj	
Cuyahoga River Basin			
Akron	Sludge will be vacuum-filtered and trucked to agricultural land.		Sludge will be sent
Cleveland Southerly	Sludge will be incinerated.		
New Kent	Sludge will be incinerated.		
Auburn Township Burton Butternut Creek Chardon East Claridon Mantua Randolph Ravenna Shalersboro Troy Township	Sludge handling from existing facilities will be phased out by 1977.	Sludge removed from aerated lagoons will be piped to adj	
Chagrin River Basin			
Aurora Central Chagrin E. Branch Chagrin Falls Fairmount Road Fowler's Mill Newbury Township	Sludge handling from existing facilities will be phased out by 1977.	Sludge removed from aerated lagoons will be piped to a	
Willoughby-Eastlake	Sludge will be sent via the existing pipeline to strip-mined land.		Sludge will be se

TABLE-IV-11

SLUDGE DISPOSAL

PLAN B

1977	1990	2020
to Cleveland Southerly for incineration.		Sludge will be sent via new pipeline to strip-mined land.
rated.		
-filtered and trucked to agricultural land.		Sludge will be sent via new pipeline to strip-mined land.
-filtered and trucked to agricultural land.		Sludge from Rocky River (primary) and Lakewood will be sent via pipeline to agricultural land.
dried and will be trucked to agricultural land.		Sludge from Rocky River (primary) and Lakewood will be sent via pipeline to agricultural land.
existing facilities y 1977.	Sludge removed from aerated lagoons will be piped to adjacent agricultural land.	
m-filtered and trucked to agricultural land.		Sludge will be sent via new pipeline to strip-mined land.
erated.		
erated.		
existing facilities y 1977.	Sludge removed from aerated lagoons will be piped to adjacent agricultural land.	
existing facilities y 1977.	Sludge removed from aerated lagoons will be piped to adjacent agricultural land.	
via the existing pipeline to strip-mined land.		Sludge will be sent via pipeline to agricultural land.

2

TABLE IV-12

SLUDGE DISPOSAL

	1972	1977	1990
Western Land Treatment Area	No sludge disposal facilities will be required.		Sludge r adjacent
Transmission Tunnel			
Euclid STP (Tunnel Inlet) North Olmsted STP (Tunnel Inlet) Rocky River STP (Tunnel Inlet) Willoughby-Eastlake STP (Tunnel Inlet)	Sludge will be vacuum-filtered and trucked to agricultural land.		All sluc Treatmer
Lakewood STP (Tunnel Inlet)	Sludge will be flash dried and trucked to agricultural land.		All sluc Treatmer
Easterly STP (Tunnel Inlet)	Sludge will be sent via pipeline to Cleveland Southerly for incineration.		
Southerly STP (Tunnel Inlet) Westerly STP (Tunnel Inlet)	Sludge will be incinerated.		
Rocky River In-Basin			
Hinckley Liverpool Mallet Creek Medina County New Medina Upper East Branch	Sludge handling from existing facilities will be phased out by 1977.	Sludge removed from aerated lagoons will be	
Cuyahoga River In-Basin			
Akron	Sludge will be sent by pipeline to agricultural land.		
Auburn Township Burton Butternut Creek Chardon East Claridon Mantua New Kent Randolph Ravenna Shalersboro Troy Township	Sludge handling from existing facilities will be phased out by 1977.	Sludge removed from aerated lagoons will be	
Chagrin River In-Basin			
Aurora Central Chagrin East Branch Chagrin Falls Fairmount Road Fowler's Mill Newbury Township	Sludge handling from existing facilities will be phased out by 1977.	Sludge removed from aerated lagoons will b	

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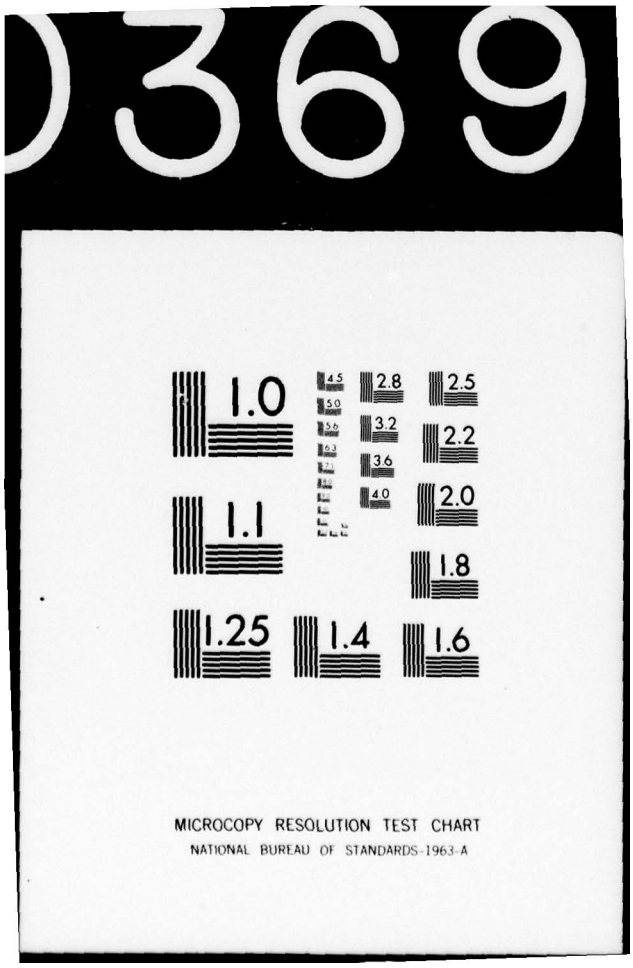
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TABLE IV-12

SLUDGE DISPOSAL — PLAN C

1977	1990	2000	2020
e disposal facilities will be required.	Sludge removed from aerated lagoon will be piped to adjacent agricultural land.		
ill be vacuum-filtered and trucked to agricultural land.	All sludge will be removed at the Western Land Treatment Area.		
ill be flash dried and trucked to agricultural land.	All sludge will be removed at the Western Land Treatment Area.		
ill be sent via pipeline to Cleveland Southerly for incineration.		All sludge will be removed at the Western Land Treatment Area.	
ill be incinerated.			
handling from existing ies will be phased out .	Sludge removed from aerated lagoons will be piped to adjacent agricultural land.		
ill be sent by pipeline to agricultural land.			
handling from existing ies will be phased out .	Sludge removed from aerated lagoons will be piped to adjacent agricultural land.		
handling from existing ies will be phased out .	Sludge removed from aerated lagoons will be piped to adjacent agricultural land.		

TABLE IV-13

STORM RUNOFF
AVERAGE ANNUAL VOLUMES TO BE TREATED
(Millions of Gallons per Year - MG/Year)

Type of Treatment Facility	1980	1990	2000	2010	2020
PLAN A					
Advanced Stormwater Treatment Plant	8,422	27,302	34,700	38,428	41,260
Municipal Sewage Treatment Plant	6,976	22,848	25,871	28,448	29,997
TOTAL	15,398	50,150	60,571	66,876	71,257
PLAN B					
Advanced Stormwater Treatment Plant	8,422	22,620	26,483	29,534	29,797
Municipal Sewage Treatment Plant	6,976	22,706	24,969	27,344	28,480
Separate Stormwater Land Treatment		3,550	7,018	8,477	9,956
Municipal Land Treatment Facility		1,274	2,101	2,521	3,024
TOTAL	15,398	50,150	60,571	67,876	71,257
PLAN C					
Advanced Stormwater Treatment Plant	1,642	10,575	13,738	15,013	16,230
Municipal Sewage Treatment Plant	13,756	1,241	1,546	1,856	2,014
Separate Stormwater Land Treatment		3,550	7,018	8,477	9,956
Municipal Land Treatment Facility		1,880	2,794	3,318	3,891
Transmission Tunnel Land Treatment		32,904	35,475	38,212	39,166
TOTAL	15,398	50,150	60,571	66,876	71,257

TABLE IV-14

STORM RUNOFF TREATMENT

PLAN A

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CH-1,2	'80-'85	Earthen	F	330.8	11.0	Water-based in Munic. Facility	Willoughby-Eastlake	Adv. Biological Treatment Plant
CH-3	'85-'90	Earthen	F	72.0	2.4	Water-based in Munic. Facility	Willoughby-Eastlake	Adv. Biological Treatment Plant
CH-4	1990	Earthen	F	29.9	1.0	Water-based in Munic. Facility	Willoughby-Eastlake	Adv. Biological Treatment Plant
CH-5	2000	Earthen	F	38.7	1.3	Water-based in Munic. Facility	Willoughby-Eastlake	Adv. Biological Treatment Plant
CH-6	1990	Earthen	F	19.1	.7	Water-based in Munic. Facility	Willoughby-Eastlake	Adv. Biological Treatment Plant
CH-7	1990	Earthen	D	3.9	1.3	Separate Water-Based Treatment	CH-7	Adv. Stormwater Treatment Plant
CH-8	1990	Earthen	D	5.4	1.8	Separate Water-Based Treatment	CH-8	Adv. Stormwater Treatment Plant
CH-9	1990	Earthen	D	11.3	3.8	Separate Water-Based Treatment	CH-9	Adv. Stormwater Treatment Plant
CH-10	'85-'90	Earthen	D	32.1	10.7	Separate Water-Based Treatment	CH-10	Adv. Stormwater Treatment Plant
CH-11	2000	Earthen	D	18.1	6.0	Separate Water-Based Treatment	CH-11	Adv. Stormwater Treatment Plant
CH-12,13	1990	Earthen	D	24.7	8.2	Separate-Water Based Treatment	CH-12, 13	Adv. Stormwater Treatment Plant
CH-16,17,18	1990	Earthen	F	51.0	1.7	Water-Based In Munic. Facility	Fairmount Road	Adv. Biological Treatment Plant
CH-19	2000	Earthen	D	3.2	1.1	Separate Water-Based Treatment	CH-19	Adv. Stormwater Treatment Plant

TABLE IV-14
Page 2

PLAN A

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CH-20	2000	Earthen	D	3.2	1.1	Separate Water-Based Treatment	CH-20	Adv. Stormwater Treatment Plant
CH-21,22	2000	Earthen	D	5.4	1.7	Separate Water-Based Treatment	CH-21, 22	Adv. Stormwater Treatment Plant
CH-23,26,27	'80-'85	Earthen	F	29.9	1.0	Water-based in Munic. Facility	Chagrin Falls	Adv. Biological Treatment Plant
CH-24	2000	Earthen	D	13.0	4.3	Separate Water-Based Treatment	CH-24	Adv. Stormwater Treatment Plant
CH-25	2000	Earthen	D	12.0	4.0	Separate Water-Based Treatment	CH-25	Adv. Stormwater Treatment Plant
CH-28	2000	Earthen	F	11.0	.3	Water-based in Munic. Facility	McFarland Creek	Adv. Biological Treatment Plant
CH-29	2000	Earthen	D	3.2	1.1	Separate Water-Based Treatment	CH-29	Adv. Stormwater Treatment Plant
CH-30,32N	1990	Earthen	F	24.0	.8	Water-based in Munic. Facility	Aurora Central	Adv. Biological Treatment Plant
CH-31	2000	Earthen	D	7.4	2.5	Separate Water-Based Treatment	CH-31	Adv. Stormwater Treatment Plant
CH-32S,33	1990	Earthen	D	7.6	2.5	Separate Water-Based Treatment	CH-32S, 33	Adv. Stormwater Treatment Plant
CH-34	2000	Earthen	D	3.7	1.2	Separate Water-Based Treatment	CH-34	Adv. Stormwater Treatment Plant
CH-35	1990	Earthen	D	8.3	2.8	Separate Water-Based Treatment	CH-35	Adv. Stormwater Treatment Plant
CH-36	2000	Earthen	D	12.3	4.1	Separate Water-Based Treatment	CH-36	Adv. Stormwater Treatment Plant

TABLE IV-14
Page 3

PLAN A

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
R-1,4,5	'80-'85	Concrete	B	20.3	6.8	Water-Based In Munic. Facility	Westerly	Physical-Chemical Treatment Plant
R-3	'80-'85	Concrete	A	17.6	144.0	Separate Water-Based Treatment	R-3	Adv. Stormwater Treatment Plant
R-6,7,8N	'80-'85	Earthen	D	72.0	24.0	Separate Water-Based Treatment	R-6, 7, 8N	Adv. Stormwater Treatment Plant
R-8S,11, 19	'80-'85	Earthen	D	57.3	15.8	Separate Water-Based Treatment	R-8S, 11, 19	Adv. Stormwater Treatment Plant
R-9	'75-'80	Concrete	B	2.1	.7	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
R-10	'80-'85	Earthen	D	69.1	23.0	Separate Water Based Treatment	R-10	Adv. Stormwater Treatment Plant
R-12	1990	Earthen	D	58.3	19.4	Separate Water Based Treatment	R-12	Adv. Stormwater Treatment Plant
R-13	'80-'85	Earthen	D	81.8	27.3	Separate Water Based Treatment	R-13	Adv. Stormwater Treatment Plant
R-14,21	1990	Earthen	D	13.2	4.3	Separate Water Based Treatment	R-14, 21	Adv. Stormwater Treatment Plant
R-15,22	1990	Earthen	D	23.3	7.8	Separate Water Based Treatment	R-15, 22	Adv. Stormwater Treatment Plant
R-16,17	'85-'90	Earthen	D	3.6	1.2	Separate Water Based Treatment	R-16, 17	Adv. Stormwater Treatment Plant

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PLAN A

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
R-18	1990	Earthen	D	27.0	9.0	Separate Water-Based Treatment	R-18	Adv. Stormwater Treatment Plant
R-20	1990	Earthen	D	27.0	9.0	Separate Water-Based Treatment	R-20	Adv. Stormwater Treatment Plant
R-23,25N	1990	Earthen	F	44.8	1.5	Water-Based in Munic. Facility	Liverpool	Adv. Biological Treatment Plant
R-24	1990	Earthen	D	23.0	7.7	Separate Water-Based Treatment	R-24	Adv. Stormwater Treatment Plant
R-25S,26	2000	Earthen	F	29.9	1.0	Water-Based in Munic. Facility	Liverpool	Adv. Biological Treatment Plant
R-27	1990	Earthen	F	43.4	1.5	Water-Based in Munic. Facility	Liverpool	Adv. Biological Treatment Plant
R-28	1990	Earthen	D	63.9	21.3	Separate Water-Based Treatment	R-28	Adv. Stormwater Treatment Plant
R-29	2000	Earthen	D	12.3	4.1	Separate Water-Based Treatment	R-29	Adv. Stormwater Treatment Plant
R-30,33	2000	Earthen	D	9.1	3.0	Separate Water-Based Treatment	R-30,33	Adv. Stormwater Treatment Plant
R-31	2000	Earthen	D	2.0	0.7	Separate Water-Based Treatment	R-31	Adv. Stormwater Treatment Plant
R-32	1990	Earthen	D	19.1	6.4	Separate Water-Based Treatment	R-32	Adv. Stormwater Treatment Plant
R-34	'85-'90	Earthen	D	15.9	5.3	Separate Water-Based Treatment	R-34	Adv. Stormwater Treatment Plant

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DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
R-35	'85-'90	Earthen	D	21.1	7.0	Separate Water-Based Treatment	R-35	Adv. Stormwater Treatment Plant
LE-1	'80-'85	Concrete	A	15.2	193.0	Separate Water-Based Treatment	LE-1	Adv. Stormwater Treatment Plant
LE-2	'80-'85	Concrete	A	26.7	173.0	Separate Water-Based Treatment	LE-2	Adv. Stormwater Treatment Plant
LE-3	'80-'85	Concrete	B	38.1	12.7	Water-Based in Munic. Facility	Euclid	Adv. Biological Treatment Plant
LE-4	'80-'85	Concrete	B	80.0	26.7	Water-Based in Munic. Facility	Easterly	Adv. Biological Treatment Plant
LE-5	'75-'80	Concrete	B	124.5	41.5	Water-Based in Munic. Facility	Easterly	Adv. Biological Treatment Plant
LE-6	'75-'80	Concrete	A	40.6	240.0	Separate Water-Based Treatment	LE-6	Adv. Stormwater Treatment Plant
LE-7	'75-'80	Concrete	B	34.3	11.4	Water-Based in Munic. Facility	Westerly	Physical-Chemical Treatment Plant
LE-8	'80-'85	Concrete	A	25.4	180	Separate Water-Based Treatment	LE-8	Adv. Stormwater Treatment Plant
LE-9	'80-'85	Concrete	B	39	13.0	Water-Based in Munic. Facility	Rocky River	Physical-Chemical Treatment Plant
LE-10	'80-'85	Concrete	A	16.9	182	Separate Water-Based Treatment	LE-10	Adv. Stormwater Treatment Plant
LE-11,12	'85-'90	Concrete	A	58.6	169	Separate Water-Based Treatment	LE-11, 12	Adv. Stormwater Treatment Plant
CU-1	'75-80	Concrete	A	24.1	178	Separate Water-Based Treatment	CU-1	Adv. Stormwater Treatment Plant

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PLAN A

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-2	'75-'80	Concrete	A	35.6	228.	Separate Water-Based Treatment	CU-2	Adv. Stormwater Treatment Plant
CU-3	'75-'80	Concrete	A	29.2	191.	Separate Water-Based Treatment	CU-3	Adv. Stormwater Treatment Plant
CU-4A	'75-'80	Concrete	A	33.2	54.	Separate Water-Based Treatment	CU-4A	Adv. Stormwater Treatment Plant
CU-4B	'80-'85	Earthen	F	326.9	10.9	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-4C	'80-'85	Earthen	F	326.9	10.9	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-4D	'80-'85	Earthen	F	326.9	10.9	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-5	'75-'80	Concrete	A	65.2	310.	Separate Water-Based Treatment	CU-5	Adv. Stormwater Treatment Plant
CU-6,12	'80-'85	Concrete	B	30.3	10.1	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-7,18	'85-'90	Earthen	F	133.8	4.5	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-8	'80-'85	Earthen	F	226.9	7.6	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-9	2000	Earthen	F	22.1	.7	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-10	1990	Earthen	F	32.1	1.1	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-11	'80-'85	Earthen	F	86.0	2.9	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant

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DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-13	'85-'90	Earthen	D	42.1	14.0	Separate Water-Based Treatment	CU-13	Adv. Stormwater Treatment Plant
CU-14	'85-'90	Earthen	F	100.0	3.3	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-15	1990	Earthen	F	11.0	.3	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-16	'85-'90	Earthen	F	38.9	1.3	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-17	'85-'90	Earthen	F	28.9	1.0	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-19,20,32	'85-'90	Earthen	D	66.6	22.2	Separate Water-Based Treatment	CU-19, 20, 32	Adv. Stormwater Treatment Plant
CU-21	1990	Earthen	F	32.1	1.1	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-22	1990	Earthen	F	21.1	.7	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-23	'85-'90	Earthen	F	23.0	.8	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-24	'85-'90	Earthen	F	34.1	1.1	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-25,35	'85-'90	Earthen	D	95.1	31.7	Separate Water-Based Treatment	CU-25, 35	Adv. Stormwater Treatment Plant
CU-26	'85-'90	Earthen	D	9.1	3.0	Separate Water-Based Treatment	CU-26	Adv. Stormwater Treatment Plant
CU-27	'85-'90	Earthen	D	22.5	7.5	Separate Water-Based Treatment	CU-27	Adv. Stormwater Treatment Plant

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PLAN A

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-28	1990	Earthen	D	9.1	3.0	Separate Water-Based Treatment	CU-28	Adv. Stormwater Treatment Plant
CU-29,31	2000	Earthen	D	36.5	12.2	Separate Water-Based Treatment	CU-29, 31	Adv. Stormwater Treatment Plant
CU-30	2000	Earthen	D	9.6	3.2	Separate Water-Based Treatment	CU-30	Adv. Stormwater Treatment Plant
CU-33	'85-'90	Earthen	F	27.0	.9	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-34A	2000	Earthen	D	3.7	1.2	Separate Water-Based Treatment	CU-34A	Adv. Stormwater Treatment Plant
CU-34B	2000	Earthen	D	2.7	0.9	Separate Water-Based Treatment	CU-34B	Adv. Stormwater Treatment Plant
CU-34C,40,41	2000	Earthen	D	11.8	3.9	Separate Water-Based Treatment	CU-34C, 40, 41	Adv. Stormwater Treatment Plant
CU-34D	2000	Earthen	D	5.9	2.0	Separate Water-Based Treatment	CU-34D	Adv. Stormwater Treatment Plant
CU-36	2000	Earthen	D	15.4	5.1	Separate Water-Based Treatment	CU-36	Adv. Stormwater Treatment Plant
CU-37	2000	Earthen	D	14.9	5.0	Separate Water-Based Treatment	CU-37	Adv. Stormwater Treatment Plant
CU-38	2000	Earthen	D	10.0	3.3	Separate Water-Based Treatment	CU-38	Adv. Stormwater Treatment Plant
CU-39	1990	Earthen	D	21.3	7.1	Separate Water-Based Treatment	CU-39	Adv. Stormwater Treatment Plant
CU-42	1990	Earthen	D	4.4	1.5	Separate Water-Based Treatment	CU-42	Adv. Stormwater Treatment Plant

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DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY NAME	FACILITY DESCRIPTION
CU-43,44,45 46,47,54	'80-'85	Earthen	F	284.2	9.5	Water-Based in Municipal Facl.	Akron	Municipal, Adv. Bio. Trmt. Plant
CU-48,55,56	'80-'85	Concrete	A	48.0	350.	Separate Water-Based Treatment	CU-48, 55, 56	Adv. Stormwater Treatment Plant
CU-49,50,57	'85-'90	Earthen	D	93.1	31.0	Separate Water-Based Treatment	CU-49, 50, 57	Adv. Stormwater Treatment Plant
CU-51A,58	'80-'85	Earthen	F	45.1	1.5	Water-Based in Munic. Facility	Kent	Physical-Chemical Treatment Plant
CU-51B,52	'85-'90	Earthen	D	77.0	25.7	Separate Water-Based Treatment	CU-51B, 52	Adv. Stormwater Treatment Plant
CU-53	'80-'85	Earthen	F	155.1	5.2	Water-Based in Munic. Facility	Ravenna	Adv. Biological Treatment Plant
CU-59	'80-'85	Earthen	D	21.3	162.	Separate Water-Based Treatment	CU-59	Adv. Stormwater Treatment Plant
CU-60,61W 63E,64W	'75-'80	Concrete	A	54.9	400.	Separate Water-Based Treatment	CU-60, 61W 63E, 64W	Adv. Stormwater Treatment Plant
CU-61E,62	'80-'85	Concrete	A	33.2	242.	Separate Water-Based Treatment	CU-61E, 62	Adv. Stormwater Treatment Plant
CU-63W	'80-'85	Concrete	A	8.2	61.	Separate Water-Based Treatment	CU-63W	Adv. Stormwater Treatment Plant
CU-64SE	'75-'80	Concrete	A	11.5	90.	Separate Water-Based Treatment	CU-64SE	Adv. Stormwater Treatment Plant
CU-64NE,65	'75-'80	Concrete	A	4.5	37.	Separate Water-Based Treatment	CU-64NE, 65	Adv. Stormwater Treatment Plant
CU-66	'80-'85	Earthen	D	37.0	12.3	Separate Water-Based Treatment	CU-66	Adv. Stormwater Treatment Plant

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DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-67,71	'85-'90	Earthen	D	40.7	13.6	Separate Water-Based Treatment	CU-67, 71	Adv. Stormwater Treatment Plant
CU-68	'80-'85	Concrete	A	26.7	156.	Separate Water-Based Treatment	CU-68	Adv. Stormwater Treatment Plant
CU-69,70	'80-'85	Concrete	A	62.3	447.	Separate Water-Based Treatment	CU-69, 70	Adv. Stormwater Treatment Plant
CU-73,74	2000	Earthen	D	14.0	4.7	Separate Water-Based Treatment	CU-73, 74	Adv. Stormwater Treatment Plant
CU-75,76	2000	Earthen	D	16.9	5.6	Separate Water-Based Treatment	CU-75, 76	Adv. Stormwater Treatment Plant
CU-77	2000	Earthen	D	9.6	3.2	Separate Water-Based Treatment	CU-77	Adv. Stormwater Treatment Plant
CU-78,79,81	2000	Earthen	F	66.9	2.2	Water-Based in Munic. Facility	Middlefield	Adv. Biological Treatment Plant
CU-82	2000	Earthen	D	4.5	1.5	Separate Water-Based Treatment	CU-82	Adv. Stormwater Treatment Plant
CU-83	'85-'90	Earthen	F	18.4	.6	Water-Based in Munic. Facility	Burton	Adv. Biological Treatment Plant
CU-84	'85-'90	Earthen	F	14.9	.5	Water-Based in Munic. Facility	Mantua	Adv. Biological Treatment Plant

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STORM RUNOFF TREATMENT

PLAN B

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CH-1,2	'80-'85	Earthen	F	330.8	11.0	Water-based in Munic. Facility	Willoughby-Eastlake	Adv. Biological Treatment Plant
CH-3	'85-'90	Earthen	F	72.0	2.4	Water-based in Munic. Facility	Willoughby-Eastlake	Adv. Biological Treatment Plant
CH-4	1990	Earthen	F	29.9	1.0	Water-based in Munic. Facility	Willoughby-Eastlake	Adv. Biological Treatment Plant
CH-5	2000	Earthen	F	38.7	1.3	Water-based in Munic. Facility	Willoughby-Eastlake	Adv. Biological Treatment Plant
CH-6	1990	Earthen	F	19.1	.7	Water-based in Munic. Facility	Willoughby-Eastlake	Adv. Biological Treatment Plant
CH-7	1990	Earthen	E	12.0	4.0	Separate Land Trmt. In-basin	CH-7	Winter Reservoir and Land Site
CH-8	1990	Earthen	E	14.7	4.9	Separate Land Trmt. In-basin	CH-8	Winter Reservoir and Land Site
CH-9	1990	Earthen	D	11.3	3.8	Separate Water-Based Treatment	CH-9	Adv. Stormwater Treatment Plant
CH-10	'85-'90	Earthen	D	32.1	10.7	Separate Water-Based Treatment	CH-10	Adv. Stormwater Treatment Plant
CH-11	2000	Earthen	D	18.1	6.0	Separate Water-Based Treatment	CH-11	Adv. Stormwater Treatment Plant
CH-12,13	1990	Earthen	E	65.9	22.0	Separate Land Trmt. In-basin	CH-12,13	Winter Reservoir and Land Site
CH-16,17,18	1990	Earthen	F	51.0	1.7	Land In-basin thru Mun. Fac.	Fairmount Road	Aerated Lagoon
CH-19	2000	Earthen	E	9.3	3.1	Separate Land Trmt. In-Basin	CH-19	Winter Reservoir and Land Site

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STORM RUNOFF TREATMENT

Plan B

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CH-20	2000	Earthen	E	9.3	3.1	Separate Land Trmt. In-Basin	CH-20,21,22	Winter Reservoir and Land Site
CH-21,22	2000	Earthen	E	5.4	1.8	Separate Land Trmt. In-Basin	CH-20,21,22	Winter Reservoir and Land Site
CH-23,26,27	'80-'85	Earthen	F	29.9	1.0	Land In-Basin thru Municipal Facility	Chagrin Falls	Aerated Lagoon
CH-24	2000	Earthen	E	36.0	12.0	Separate Land Trmt. In-Basin	CH-24	Winter Reservoir and Land Site
CH-25	2000	Earthen	E	32.1	10.7	Separate Land Trmt. In-Basin	CH-25	Winter Reservoir and Land Site
CH-28	2000	Earthen	E	11.0	3.7	Separate Land Trmt. In-Basin	CH-28	Winter Reservoir and Land Site
CH-29	2000	Earthen	E	2.0	.7	Separate Land Trmt. In-Basin	CH-29	Winter Reservoir and Land Site
CH-30,32N	1990	Earthen	F	24.0	.8	Land In-bas. thru Munic. Facility	Aurora Central	Aerated Lagoon
CH-31	2000	Earthen	E	7.4	2.5	Separate Land Trmt. In-Basin	CH-31	Winter Reservoir and Land Site
CH-32S,33	1990	Earthen	E	41.2	13.7	Separate Land Trmt. In-Basin	CH-32S, 33, 34	Winter Reservoir and Land Site
CH-34	2000	Earthen	E	10.0	3.3	Separate Land Trmt. In-Basin	CH-32S, 33, 34	Winter Reservoir and Land Site
CH-35	1990	Earthen	E	8.3	2.8	Separate Land Trmt. In-Basin	CH-35, 36	Winter Reservoir and Land Site
CH-36	2000	Earthen	E	12.3	4.1	Separate Land Trmt. In-Basin	CH-35,36	Winter Reservoir and Land Site

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PLAN B

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
R-1,4,5	'80-'85	Concrete	B	20.3	6.8	Water-based in Munic. Facility	Westerly	Physical-chemical Treatment Plant
R-3	'80-'85	Concrete	A	17.6	144.0	Separate Water-Based Treatment	R-3	Adv. Stormwater Treatment Plant
R-6,7,8N	'80-'85	Earthen	D	72.0	24.0	Separate Water-Based Treatment	R-6,7,8N	Adv. Stormwater Treatment Plant
R-8S,11	'80-'85	Earthen	D	49.2	16.4	Separate Water-Based Treatment	R-8S, 11	Adv. Stormwater Treatment Plant
R-9	'75-'80	Concrete	B	2.1	.7	Water-based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
R-10	'80-'85	Earthen	D	69.1	23.0	Separate Water Based Treatment	R-10	Adv. Stormwater Treatment Plant
R-12	1990	Earthen	D	58.3	19.4	Separate Water Based Treatment	R-12	Adv. Stormwater Treatment Plant
R-13	'80-'85	Earthen	D	81.8	27.3	Separate Water Based Treatment	R-13	Adv. Stormwater Treatment Plant
R-14,21	1990	Earthen	D	13.2	4.3	Separate Water Based Treatment	R-14, 21	Adv. Stormwater Treatment Plant
R-15,22	1990	Earthen	D	23.3	7.8	Separate Water Based Treatment	R-15, 22	Adv. Stormwater Treatment Plant
R-16,17	'85-'90	Earthen	D	3.6	1.2	Separate Water Based Treatment	R-16, 17	Adv. Stormwater Treatment Plant

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Plan B

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
R-18	1990	Earthen	D	27.0	9.0	Separate Water-Based Treatment	R-18	Adv. Stormwater Treatment Plant
R-19	2000	Earthen	E	84.0	28.0	Separate Land Trmt. In-Basin	R-19	Winter Reservoir and Land Site
R-20	1990	Earthen	E	66.2	22.1	Separate Land Trmt. In-Basin	R-20	Winter Reservoir and Land Site
R-23,25N	1990	Earthen	F	44.8	1.5	Land in-basin thru munc. fac.	Liverpool	Aerated Lagoon
R-24	1990	Earthen	E	69.1	23.0	Separate Land Trmt. In-Basin	R-24	Winter Reservoir and Land Site
R-25S,26	2000	Earthen	E	29.9	10.0	Separate Land Trmt. In-Basin	R-25S, 26	Winter Reservoir and Land Site
R-27	1990	Earthen	E	43.4	14.5	Separate Land Trmt. In-Basin	R-27	Winter Reservoir and Land Site
R-28	1990	Earthen	E	178.9	59.6	Separate Land Trmt. In-Basin	R-28	Winter Reservoir and Land Site
R-29	2000	Earthen	E	34.1	10.4	Separate Land Trmt. In-Basin	R-29	Winter Reservoir and Land Site
R-30,33	2000	Earthen	E	24.3	8.1	Separate Land Trmt. In-Basin	R-30, 33	Winter Reservoir and Land Site
R-31	2000	Earthen	E	14.0	4.7	Separate Land Trmt. In-Basin	R-31, 32	Winter Reservoir and Land Site
R-32	1990	Earthen	E	58.8	19.6	Separate Land Trmt. In-Basin	R-31, 32	Winter Reservoir and Land Site
R-34	'85-'90	Earthen	E	36.0	16.0	Separate Land Trmt. In-Basin	R-34, 35	Winter Reservoir and Land Site

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PLAN B

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
R-35	'85-'90	Earthen	E	60.0	20.0	Separate Land Trmt. In-Basin	R-34,35	Winter Reservoir and Land Site
LE-1	'80-'85	Concrete	A	15.2	193.0	Separate Water-Based Treatment	LE-1	Adv. Stormwater Treatment Plant
LE-2	'80-'85	Concrete	A	26.7	173.0	Separate Water-Based Treatment	LE-2	Adv. Stormwater Treatment Plant
LE-3	'80-'85	Concrete	B	38.1	12.7	Water-based in Munic. Facility	Euclid	Adv. Biological Treatment Plant
LE-4	'80-'85	Concrete	B	80.0	26.7	Water-based in Munic. Facility	Easterly	Adv. Biological Treatment Plant
LE-5	'75-'80	Concrete	B	124.5	41.5	Water-based in Munic. Facility	Easterly	Adv. Biological Treatment Plant
LE-6	'75-'80	Concrete	A	40.6	240.0	Separate Water-Based Treatment	LE-6	Adv. Stormwater Treatment Plant
LE-7	'75-'80	Concrete	B	34.3	11.4	Water-based In Munic. Facility	Westerly	Physical-chemical Treatment Plant
LE-8	'80-'85	Concrete	A	25.4	180.0	Separate Water-Based Treatment	LE-8	Adv. Stormwater Treatment Plant
LE-9	'80-'85	Concrete	B	39.	13.0	Water-based in Munic. Facility	Rocky River	Physical-chemical Treatment Plant
LE-10	'80-'85	Concrete	A	16.9	182.0	Separate Water-Based Treatment	LE-10	Adv. Stormwater Treatment Plant
LE-11,12	'85-'90	Concrete	A	58.6	169.0	Separate Water-Based Treatment	LE-11, 12	Adv. Stormwater Treatment Plant
CU-1	'75-80	Concrete	A	24.1	178.0	Separate Water-Based Treatment	CU-1	Adv. Stormwater Treatment Plant

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PLAN B

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-2	'75-'80	Concrete	A	35.6	228.0	Separate Water-Based Treatment	CU-2	Adv. Stormwater Treatment Plant
CU-3	'75-'80	Concrete	A	29.2	191.0	Separate Water-Based Treatment	CU-3	Adv. Stormwater Treatment Plant
CU-4A	'75-'80	Concrete	A	33.2	54.0	Separate Water-Based Treatment	CU-4A	Adv. Stormwater Treatment Plant
CU-4B	'80-'85	Earthen	F	326.9	10.9	Water Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-4C	'80-'85	Earthen	F	326.9	10.9	Water Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-4D	'80-'85	Earthen	F	326.9	10.9	Water Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-5	'75-'80	Concrete	A	65.2	310.0	Separate Water Based Treatment	CU-5	Adv. Stormwater Treatment Plant
CU-6,12	'80-'85	Concrete	B	30.3	10.1	Water Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-7,18	'85-'90	Earthen	F	133.8	4.5	Water Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-8	'80-'85	Earthen	F	226.9	7.6	Water Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-9	2000	Earthen	F	22.1	.7	Water Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-10	1990	Earthen	F	32.1	1.1	Water Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-11	'80-'85	Earthen	F	86.0	2.9	Water Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant

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PLAN B

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-13	'85-'90	Earthen	D	42.1	14.0	Separate Water-Based In-Basin	CU-13	Adv. Stormwater Treatment Plant
CU-14	'85-'90	Earthen	F	100.0	3.3	Water-Based In Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-15	1990	Earthen	F	11.0	.3	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-16	'85-'90	Earthen	F	38.9	1.3	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-17	'85-'90	Earthen	F	28.9	1.0	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-19,20,32	'85-'90	Earthen	D	66.6	22.2	Separate Water-Based Treatment	CU-19, 20, 32	Adv. Stormwater Treatment Plant
CU-21	1990	Earthen	F	32.1	1.1	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-22	1990	Earthen	F	21.1	.7	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-23	'85-'90	Earthen	F	23.0	.8	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-24	'85-'90	Earthen	F	34.1	1.1	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-25,35	'85-'90	Earthen	D	95.1	31.7	Separate Water-Based Treatment	CU-25, 35	Adv. Stormwater Treatment Plant
CU-26	'85-'90	Earthen	E	27.0	9.0	Separate Land Trmt. In-Basin	CU-26, 27	Winter Reservoir and Land Site
CU-27	'85-'90	Earthen	E	62.7	20.9	Separate Land Trmt. In-Basin	CU-26, 27	Winter Reservoir and Land Site

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PLAN B

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-28	1990	Earthen	E	24.0	8.0	Separate Land Trmt. In-Basin	CU-28	Winter Reservoir and Land Site
CU-29,31	2000	Earthen	E	99.0	33.0	Separate Land Trmt. In-Basin	CU-29, 31	Winter Reservoir and Land Site
CU-30	2000	Earthen	E	25.5	8.5	Separate Land Trmt. In-Basin	CU-30	Winter Reservoir and Land Site
CU-33	'85-'90	Earthen	F	27.0	.9	Water-Based in Munic. Facility	Southerly	Adv. Biological Treatment Plant
CU-34A	2000	Earthen	D	3.7	1.2	Separate Water-Based Treatment	CU-34A	Adv. Stormwater Treatment Plant
CU-34B	2000	Earthen	D	2.7	0.9	Separate Water-Based Treatment	CU-34B	Adv. Stormwater Treatment Plant
CU-34C,40,41	2000	Earthen	E	27.0	9.0	Separate Land Trmt. In-Basin	CU-34C,40,41	Winter Reservoir and Land Site
CU-34D	2000	Earthen	D	5.9	2.0	Separate Water-Based Treatment	CU-34D	Adv. Stormwater Treatment Plant
CU-36	2000	Earthen	E	40.9	13.6	Separate Land Trmt. In-Basin	CU-36	Winter Reservoir and Land Site
CU-37	2000	Earthen	E	39.9	13.3	Separate Land Trmt. In-Basin	CU-37	Winter Reservoir and Land Site
CU-38	2000	Earthen	E	27.0	9.0	Separate Land Trmt. In-Basin	CU-38	Winter Reservoir and Land Site
CU-39	1990	Earthen	E	57.8	19.3	Separate Land Trmt. In-Basin	CU-39	Winter Reservoir and Land Site
CU-42	1990	Earthen	E	21.1	7.0	Separate Land Trmt. In-Basin	CU-42	Winter Reservoir and Land Site

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PLAN B

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-43,44,45 46,47,54	'80-'85	Earthen	F	284.2	9.5	Water-Based in Municipal Facl.	Akron	Municipal, Adv. Bio. Trmt. Plant
CU-48,55,56	'80-'85	Concrete	A	48.0	350.0	Separate Water-Based Treatment	CU-48, 55, 56	Adv. Stormwater Treatment Plant
CU-49,50,57	'85-'90	Earthen	D	93.1	31.0	Separate Water-Based Treatment	CU-49, 50, 57	Adv. Stormwater Treatment Plant
CU-51A,58	'80-'85	Earthen	E	45.1	15.0	Water Based in Munic. Facility	New Kent	Physical-Chemical Treatment Plant
CU-51B,52	'85-'90	Earthen	E	102.9	34.3	Separate Land Trmt. In-Basin	CU-51B, 52	Winter Reservoir and Land Site
CU-53	'80-'85	Earthen	E	155.1	51.7	Land In-Basin thru Munic.Fac.	Ravenna	Aerated Lagoon
CU-59	'80-'85	Earthen	D	21.3	162.0	Separate Land Trmt. In-Basin	CU-59	Winter Reservoir and Land Site
CU-60,61W 63E,64W	'75-'80	Concrete	A	54.9	400.0	Separate Water-Based Treatment	CU-60, 61W 63E, 64W	Adv. Stormwater Treatment Plant
CU-61E,62	'80-'85	Concrete	A	33.2	242.0	Separate Water-Based Treatment	CU-61E, 62	Adv. Stormwater Treatment Plant
CU-63W	'80-'85	Concrete	A	8.2	61.0	Separate Land Trmt. In-Basin	CU-63W	Winter Reservoir and Land Site
CU-64SE	'75-'80	Concrete	A	11.5	90.0	Separate Water-Based Treatment	CU-64SE	Adv. Stormwater Treatment Plant
CU-64NE,65	'75-'80	Concrete	A	4.5	37.0	Separate Water-Based Treatment	CU-64NE, 65	Adv. Stormwater Treatment Plant
CU-66	'80-'85	Earthen	D	37.0	12.3	Separate Water-Based Treatment	CU-66	Adv. Stormwater Treatment Plant

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DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-67,71	'85-'90	Earthen	E	116.1	38.7	Separate Land Trmt. In-Basin	CU-67, 71	Winter Reservoir and Land Site
CU-68	'80-'85	Concrete	A	26.7	156.0	Separate Water-Based Treatment	CU-68	Adv. Stormwater Treatment Plant
CU-69,70	'80-'85	Concrete	A	62.3	447.0	Separate Water-Based Treatment	CU-69, 70	Adv. Stormwater Treatment Plant
CU-73,74	2000	Earthen	E	38.2	12.7	Separate Land Trmt. In-Basin	CU-73, 74	Winter Reservoir and Land Site
CU-75,76	2000	Earthen	E	46.1	15.4	Separate Land Trmt. In-Basin	CU-75, 76	Winter Reservoir and Land Site
CU-77	2000	Earthen	E	26.0	8.7	Separate Land Trmt. In-Basin	CU-77	Winter Reservoir and Land Site
CU-78,79,81	2000	Earthen	F	66.9	2.2	Land In-Basin thru Munic.Fac.	Burton	Aerated Lagoon
CU-82	2000	Earthen	E	7.1	2.4	Separate Land Trmt. In-Basin	CU-82	Winter Reservoir and Land Site
CU-83	2000	Earthen	F	18.4	.6	Land In-Basin thru Munic.Fac.	Burton	Aerated Lagoon
CU-84	'80-'85	Earthen	F	14.9	.5	Land In-Basin thru Munic.Fac.	Mantua	Aerated Lagoon

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STORM RUNOFF TREATMENT

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DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CH-1,2	'80-'85	Earthen	F	330.8	11.0	To Tunnel thru Municipal STP	Willoughby-Eastlake	Municipal STP to be phased out
CH-3	'85-'90	Earthen	F	72.0	2.4	To Tunnel thru Municipal STP	Willoughby-Eastlake	Municipal STP to be phased out
CH-4	1990	Earthen	F	29.9	1.0	To Tunnel thru Municipal STP	Willoughby-Eastlake	Thru Munic. Drop Shaft after STP is phased out
CH-5	2000	Earthen	F	38.7	1.3	To Tunnel thru Municipal STP	Willoughby-Eastlake	Thru Munic. Drop Shaft after STP is phased out
CH-6	1990	Earthen	F	53.4	1.8	To Tunnel thru Municipal STP	Willoughby-Eastlake	Thru Munic. Drop Shaft after STP is phased out
CH-7	1990	Earthen	E	12.0	4.0	Separate Land Trmt. In-Basin	CH-7	Winter Reservoir and Land Site
CH-8	1990	Earthen	E	14.7	4.9	Separate Land Trmt. In-Basin	CH-8	Winter Reservoir and Land Site
CH-9	1990	Earthen	D	11.3	3.8	Separate Water-Based Treatment	CH-9	Adv. Stormwater Treatment Plant
CH-10	'85-'90	Earthen	D	32.1	10.7	Separate Water-Based Treatment	CH-10	Adv. Stormwater Treatment Plant
CH-11	2000	Earthen	D	18.1	6.0	Separate Water-Based Treatment	CH-11	Adv. Stormwater Treatment Plant
CH-12,13	1990	Earthen	E	65.9	22.0	Separate Land Trmt. In-Basin	CH-12, 13	Winter Reservoir and Land Site
CH-16,17,18	1990	Earthen	F	51.0	1.7	Land In-Basin thru Municipal facility	Fairmount Road	Aerated Lagoon
CH-19	2000	Earthen	E	9.3	3.1	Separate Land Trmt. In-Basin	CH-19	Winter Reservoir and Land Site

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STORM RUNOFF TREATMENT

Plan C

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CH-20	2000	Earthen	E	9.3	3.1	Separate Land Trmt. In-Basin	CH-20,21,22	Winter Reservoir and Land Site
CH-21,22	2000	Earthen	E	5.4	1.8	Separate Land Trmt. In-Basin	CH-20,21,22	Winter Reservoir and Land Site
CH-23,26,27	'80-'85	Earthen	F	29.9	1.0	Land In-Basin thru Municipal Facility	Chagrin Falls	Aerated Lagoon
CH-24	2000	Earthen	E	36.0	12.0	Separate Land Trmt. In-Basin	CH-24	Winter Reservoir and Land Site
CH-25	2000	Earthen	E	32.1	10.7	Separate Land Trmt. In-Basin	CH-25	Winter Reservoir and Land Site
CH-28	2000	Earthen	E	11.0	3.7	Separate Land Trmt. In-Basin	CH-28	Winter Reservoir and Land Site
CH-29	2000	Earthen	E	2.0	.7	Separate Land Trmt. In-Basin	CH-29	Winter Reservoir and Land Site
CH-30,32N	1990	Earthen	F	24.0	.8	Land In-bas. thru Munic. Facility	Aurora Central	Aerated Lagoon
CH-31	2000	Earthen	E	7.4	2.5	Separate Land Trmt. In-Basin	CH-31	Winter Reservoir and Land Site
CH-32S,33	1990	Earthen	E	41.2	13.7	Separate Land Trmt. In-Basin	CH-32S, 33, 34	Winter Reservoir and Land Site
CH-34	2000	Earthen	E	10.0	3.3	Separate Land Trmt. In-Basin	CH-32S, 33, 34	Winter Reservoir and Land Site
CH-35	1990	Earthen	E	8.3	2.8	Separate Land Trmt. In-Basin	CH-35, 36	Winter Reservoir and Land Site
CH-36	2000	Earthen	E	12.3	4.1	Separate Land Trmt. In-Basin	CH-35,36	Winter Reservoir and Land Site

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DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
R-1,4,5	'80-'85	Concrete	C	20.3	6.8	To Tunnel Direct	R-1,4,5	Separate Storm-water Drop Shaft
R-3	'80-'85	Concrete	C	17.6	5.9	To Tunnel Direct	R-3	Separate Storm-water Drop Shaft
R-6,7,8N	'80-'85	Earthen	F	72.0	2.4	To Tunnel Direct	R-6, 7, 8N, 9 N. Olmsted	Munic./Stormwater Drop Shaft
R-8S,11	'80-'85	Earthen	D	49.2	16.4	Separate Water-Based Treatment	R-8S, 11	Adv. Stormwater Treatment Plant
R-9	'75-'80	Concrete	C	2.1	.7	To Tunnel Direct	R-6, 7, 8N, 9 N. Olmsted	Munic./Stormwater Drop Shaft
R-10	'80-'85	Earthen	D	69.1	23.0	Separate Water Based Treatment	R-10	Adv. Stormwater Treatment Plant
R-12	1990	Earthen	D	58.3	19.4	Separate Water Based Treatment	R-12	Adv. Stormwater Treatment Plant
R-13	'80-'85	Earthen	D	81.8	27.3	Separate Water Based Treatment	R-13	Adv. Stormwater Treatment Plant
R-14,21	1990	Earthen	D	13.2	4.3	Separate Water Based Treatment	R-14, 21	Adv. Stormwater Treatment Plant
R-15,22	1990	Earthen	D	23.3	7.8	Separate Water Based Treatment	R-15, 22	Adv. Stormwater Treatment Plant
R-16,17	'85-'90	Earthen	D	3.6	1.2	Separate Water Based Treatment	R-16, 17	Adv. Stormwater Treatment Plant

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DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
R-18	1990	Earthen	D	27.0	9.0	Separate Water-Based Treatment	R-18	Adv. Stormwater Treatment Plant
R-19	2000	Earthen	E	84.0	28.0	Separate Land Trmt. In-Basin	R-19	Winter Reservoir and Land Site
R-20	1990	Earthen	E	66.2	22.1	Separate Land Trmt. In-Basin	R-20	Winter Reservoir and Land Site
R-23,25N	1990	Earthen	F	44.8	1.5	Land in-basin thru munc. fac.	Liverpool	Aerated Lagoon
R-24	1990	Earthen	E	69.1	23.0	Separate Land Trmt. In-Basin	R-24	Winter Reservoir and Land Site
R-25S,26	2000	Earthen	E	29.9	10.0	Separate Land Trmt. In-Basin	R-25S, 26	Winter Reservoir and Land Site
R-27	1990	Earthen	E	43.4	14.5	Separate Land Trmt. In-Basin	R-27	Winter Reservoir and Land Site
R-28	1990	Earthen	E	178.9	59.6	Separate Land Trmt. In-Basin	R-28	Winter Reservoir and Land Site
R-29	2000	Earthen	E	34.1	10.4	Separate Land Trmt. In-Basin	R-29	Winter Reservoir and Land Site
R-30,33	2000	Earthen	E	24.3	8.1	Separate Land Trmt. In-Basin	R-30, 33	Winter Reservoir and Land Site
R-31	2000	Earthen	E	14.0	4.7	Separate Land Trmt. In-Basin	R-31, 32	Winter Reservoir and Land Site
R-32	1990	Earthen	E	58.8	19.6	Separate Land Trmt. In-Basin	R-31, 32	Winter Reservoir and Land Site
R-34	'85-'90	Earthen	E	36.0	12.0	Separate Land Trmt. In-Basin	R-34, 35	Winter Reservoir and Land Site

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DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
R-35	'85-'90	Earthen	E	60.0	20.0	Separate Land Trmt. In-Basin	R-34, 35	Winter Reservoir and Land Site
LE-1	'80-'85	Concrete	C	8.9	3.0	To Tunnel Direct	LE-1	Separate Drop Shaft
LE-2	'80-'85	Concrete	C	12.7	4.2	To Tunnel Direct	LE-2	Separate Drop Shaft
LE-3	'80-'85	Concrete	C	24.1	8.0	To Tunnel Direct	LE-3 Euclid	Municipal/ Storm-water Drop Shaft
LE-4	'80-'85	Concrete	C	66.0	22.0	To Tunnel Direct	LE-4	Separate Drop Shaft
LE-5	'75-'80	Concrete	C	100.3	33.1	To Tunnel Direct	LE-5 Easterly	Municipal/Storm-water Drop Shaft
LE-6	'75-'80	Concrete	C	20.3	6.8	To Tunnel Direct	LE-6	Separate Drop Shaft
LE-7	'75-'80	Concrete	C	16.5	5.5	To Tunnel Direct	LE-7 Westerly	Municipal/Storm-water Drop shaft
LE-8	'80-'85	Concrete	C	11.4	3.8	To Tunnel Direct	LE-8 Lakewood	Municipal/Storm-water Drop Shaft
LE-9	'80-'85	Concrete	C	13.	4.3	To Tunnel Direct	LE-9,10,11,12 Rocky River	Municipal/Storm-water Drop Shaft
LE-10	'80-'85	Concrete	C	18.7	6.2	To Tunnel Direct	LE-9,10,11,12 Rocky River	Municipal/Storm-water Drop Shaft
LE-11,12	'85-'90	Concrete	C	23.0	7.7	To Tunnel Direct	LE-9,10,11,12 Rocky River	Municipal/Storm-water Drop Shaft
CU-1	'75-80	Concrete	C	33.0	11.0	To Tunnel Direct	CU-1 Westerly	Municipal/Storm-water Drop Shaft

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DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-2	'75-'80	Concrete	C	62.2	30.7	To Tunnel Direct	CU-2	Separate Drop Shaft
CU-3	'75-'80	Concrete	C	45.7	15.2	To Tunnel Direct	CU-3	Separate Drop Shaft
CU-4A	'75-'80	Concrete	C	32.0	10.7	To Tunnel Direct	CU-4A	Separate Drop Shaft
CU-4B	'80-'85	Earthen	F	326.9	10.9	To Tunnel thru Munc. STP	Southerly	Munic. STP to be Phased Out
CU-4C	'80-'85	Earthen	F	326.9	10.9	To Tunnel thru Munc. STP	Southerly	Munic. STP to be Phased Out
CU-4D	'80-'85	Earthen	F	326.9	10.9	To Tunnel thru Munic. STP	Southerly	Munic. STP to be Phased Out
CU-5	'75-'80	Concrete	C	149.2	49.7	To Tunnel Direct	CU-5 Southerly	Municipal/Storm-water Drop Shaft
CU-6,12	'80-'85	Concrete	F	45.1	1.5	To Tunnel thru Munic. STP	Southerly	Municipal STP to be phased out
CU-7,18	'85-'90	Earthen	F	133.8	4.5	To Tunnel thru Munic. STP	Southerly	Municipal STP to be phased out
CU-8	'80-'85	Earthen	F	226.9	7.6	To Tunnel thru Munic. STP	Southerly	Municipal STP to be phased out
CU-9	2000	Earthen	F	22.1	.7	To Tunnel thru Munic. STP	Southerly	Municipal STP to be phased out
CU-10	1990	Earthen	F	32.1	1.1	To Tunnel thru Munic. STP	Southerly	Municipal STP to be phased out
CU-11	'80-'85	Earthen	F	86.0	2.9	To Tunnel thru Munic. STP	Southerly	Municipal STP to be phased out

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DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-13	'85-'90	Earthen	D	42.1	14.0	Separate Water-Based Treatment	CU-13	Adv. Stormwater Treatment Plant
CU-14	'85-'90	Earthen	F	100.0	3.3	To Tunnel thru Municipal STP	Southerly	Municipal STP to be phased out
CU-15	1990	Earthen	F	11.0	.3	To Tunnel thru Municipal STP	Southerly	Municipal STP to be phased out
CU-16	'85-'90	Earthen	F	38.9	1.3	To Tunnel thru Municipal STP	Southerly	Municipal STP to be phased out
CU-17	'85-'90	Earthen	F	28.9	1.0	To Tunnel thru Municipal STP	Southerly	Municipal STP to be phased out
CU-19,20,32	'85-'90	Earthen	D	66.6	22.2	Separate Water-Based Treatment	CU-19, 20, 32	Adv. Stormwater Treatment Plant
CU-21	1990	Earthen	F	32.1	1.1	To Tunnel thru Municipal STP	Southerly	Municipal STP to be phased out
CU-22	1990	Earthen	F	21.1	.7	To Tunnel thru Municipal STP	Southerly	Municipal STP to be phased out
CU-23	'85-'90	Earthen	F	23.0	.8	To Tunnel thru Municipal STP	Southerly	Municipal STP to be phased out
CU-24	'85-'90	Earthen	F	34.1	1.1	To Tunnel thru Municipal STP	Southerly	Municipal STP to be phased out
CU-25,35	'85-'90	Earthen	D	95.1	31.7	Separate Water-Based Treatment	CU-25, 35	Adv. Stormwater Treatment Plant
CU-26	'85-'90	Earthen	E	27.1	9.0	Separate Land Trmt. In-Basin	CU-26, 27	Winter Reservoir and Land Site
CU-27	'85-'90	Earthen	E	62.7	20.9	Separate Land Trmt. In-Basin	CU-26, 27	Winter Reservoir and Land Site

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DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-28	1990	Earthen	E	24.0	8.0	Separate Land Trmt. In-Basin	CU-28	Winter Reservoir and Land Site
CU-29,31	2000	Earthen	E	99.0	33.0	Separate Land Trmt. In-Basin	CU-29, 31	Winter Reservoir and Land Site
CU-30	2000	Earthen	E	22.5	8.5	Separate Land Trmt. In-Basin	CU-30	Winter Reservoir and Land Site
CU-33	'85-'90	Earthen	F	27.0	.9	To Tunnel thru Municipal STP	Southerly	Municipal STP to be phased out
CU-34A	2000	Earthen	D	3.7	1.2	Separate Water-Based Treatment	CU-34A	Adv. Stormwater Treatment Plant
CU-34B	2000	Earthen	D	2.7	0.9	Separate Water-Based Treatment	CU-34B	Adv. Stormwater Treatment Plant
CU-34C,40,41	2000	Earthen	E	27.0	9.0	Separate Land Trmt. In-Basin	CU-34C, 40, 41	Winter Reservoir and Land Site
CU-34D	2000	Earthen	D	5.9	2.0	Separate Water-Based Treatment	CU-34D	Adv. Stormwater Treatment Plant
CU-36	2000	Earthen	E	40.9	13.6	Separate Land Trmt. In-Basin	CU-36	Winter Reservoir and Land Site
CU-37	2000	Earthen	E	39.9	13.3	Separate Land Trmt. In-Basin	CU-37	Winter Reservoir and Land Site
CU-38	2000	Earthen	E	27.0	9.0	Separate Land Trmt. In-Basin	CU-38	Winter Reservoir and Land Site
CU-39	1990	Earthen	E	57.8	19.3	Separate Land Trmt. In-Basin	CU-39	Winter Reservoir and Land Site
CU-42	1990	Earthen	E	21.1	7.0	Separate Land Trmt. In-Basin	CU-42	Winter Reservoir and Land Site

TABLE IV-16
Page 9

Plan C

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-43,44,45 46,47,54	'80-'85	Earthen	F	284.2	9.5	Water-Based in Municipal Facl.	Akron	Municipal, Adv. Bio. Trmt. Plant
CU-48,55,56	'80-'85	Concrete	A	48.0	350.0	Separate Water-Based Treatment	CU-48, 55, 56	Adv. Stormwater Treatment Plant
CU-49,50,57	'85-'90	Earthen	D	93.1	31.0	Separate Water-Based Treatment	CU-49, 50, 57	Adv. Stormwater Treatment Plant
CU-51A,58	'80-'85	Earthen	F	45.1	15.0	Land In-Basin thru munc. fac.	Kent	Aerated Lagoon
CU-51B,52	'85-'90	Earthen	E	102.9	34.3	Separate Land Trmt. In-Basin	CU-51B, 52	Winter Reservoir and Land Site
CU-53	'80-'85	Earthen	F	155.1	51.7	Land In-Basin thru munc. fac.	Ravenna	Aerated Lagoon
CU-59	'80-'85	Earthen	D	21.3	162.0	Separate Land Trmt. In-Basin	CU-59	Winter Reservoir and Land Site
CU-60,61W 63E,64W	'75-'80	Concrete	A	54.9	400.0	Separate Water-Based Treatment	CU-60, 61W 63E, 64W	Adv. Stormwater Treatment Plant
CU-61E,62	'80-'85	Concrete	A	33.2	242.0	Separate Water-Based Treatment	CU-61E, 62	Adv. Stormwater Treatment Plant
CU-63W	'80-'85	Concrete	A	8.2	61.0	Separate Land Trmt. In-Basin	CU-63W	Winter Reservoir and Land Site
CU-64SE	'75-'80	Concrete	A	11.5	90.0	Separate Water-Based Treatment	CU-64SE	Adv. Stormwater Treatment Plant
CU-64NE,65	'75-'80	Concrete	A	4.5	37.0	Separate Water-Based Treatment	CU-64NE, 65	Adv. Stormwater Treatment Plant
CU-66	'80-'85	Earthen	D	37.0	12.3	Separate Water-Based Treatment	CU-66	Adv. Stormwater Treatment Plant

TABLE IV-16
Page 10

PLAN C

DRAINAGE DISTRICTS	TO BE BUILT IN PERIOD	DETENTION				TREATMENT		
		DETENTION BASIN TYPE	SIZING OPTION	VOLUME OF BASIN (MG)	RATE OF RELEASE (MGD)	TYPE OF TREATMENT	FACILITY	
							NAME	DESCRIPTION
CU-67,71	'85-'90	Earthen	E	116.1	38.7	Separate Land Trmt. In-Basin	CU-67, 71	Winter Reservoir and Land Site
CU-68	'80-'85	Concrete	A	26.7	156.0	Separate Water-Based Treatment	CU-68	Adv. Stormwater Treatment Plant
CU-69,70	'80-'85	Concrete	A	62.3	447.0	Separate Water-Based Treatment	CU-69, 70	Adv. Stormwater Treatment Plant
CU-73,74	2000	Earthen	E	38.2	12.7	Separate Land Trmt. In-Basin	CU-73, 74	Winter Reservoir and Land Site
CU-75,76	2000	Earthen	E	46.1	15.4	Separate Land Trmt. In-Basin	CU-75, 76	Winter Reservoir and Land Site
CU-77	2000	Earthen	E	26.0	8.7	Separate Land Trmt. In-Basin	CU-77	Winter Reservoir and Land Site
CU-78,79,81	2000	Earthen	F	66.9	2.2	Land In-Basin thru munc. Fac.	Burton	Aerated Lagoon
CU-82	2000	Earthen	E	7.1	2.4	Separate Land Trmt. In-Basin	CU-82	Winter Reservoir and Land Site
CU-83	'85-90'	Earthen	F	18.4	.6	Land In-Basin thru Munc. fac.	Burton	Aerated Lagoon
CU-84	'85-'90	Earthen	F	14.9	.5	Land In-Basin thru Munc. fac.	Mantua	Aerated Lagoon


LAKE ERIE
CLEVELAND WESTERLY 46.18
CLEVELAND EASTERLY 172.00
EUCLID 37.34
WILLOUGHBY-EASTLAKE 22.27
CHAGRIN EAST BRANCH 1.95
FOWLER'S MILL 1.98
BUTTERNUT CREEK 1.17
E. CLARIDON 0.48
NEWBURY TOWNSHIP 1.56
MIDDLEFIELD
BURTON 0.91
FAIRMOUNT ROAD 3.40
CHAGRIN FALLS 3.58
CLEVELAND SOUTHERLY 234.50
LAKEWOOD 21.00
ROCKY RIVER 22.05
McFARLAND CREEK 4.29
AURORA CENTRAL 2.98
AUBURN TOWNSHIP 10.84
TROY 7.98
0.47
MANTUA 0.66
LIVERPOOL 20.09
AKRON 143.87
NEW RENT 28.41
RAVENNA 12.34
RANDOLPH 0.75
LEGEND
PLAN A

FIGURE IV-1

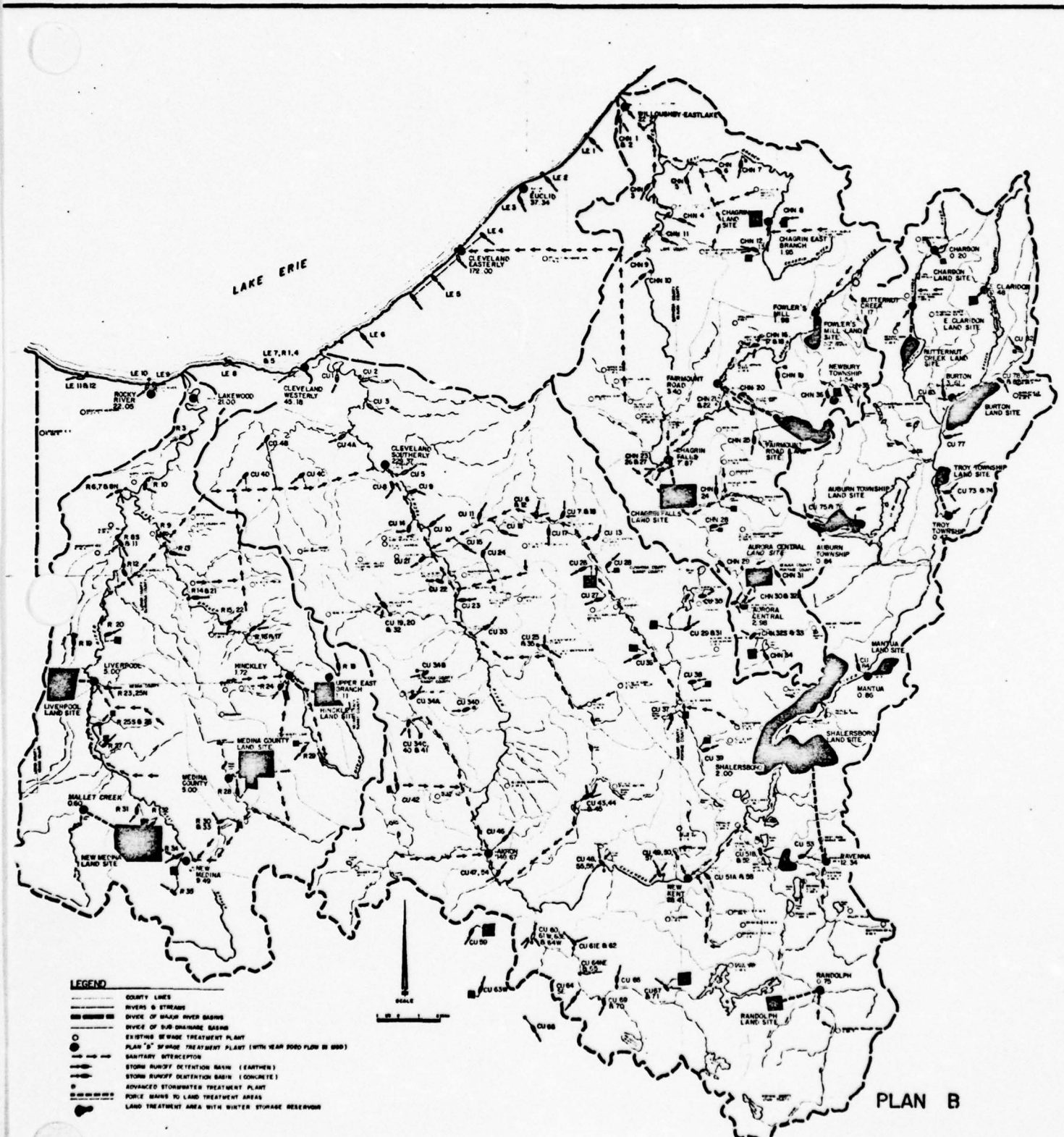

LAKE ERIE
EUCLID 37.34
CLEVELAND EASTERLY 172.00
CLEVELAND WESTERLY 40.18
CLEVELAND SOUTHERLY 228.37
ROCKY RIVER 22.05
LAKEWOOD 21.00
CHAGRIN LAND SITE
CHAGRIN EAST BRANCH 1.95
CHARDON 0.20
CHARDON LAND SITE
BUTTERNUT CREEK 1.17
BURTON 3.61
BURTON LAND SITE
NEWBURY TOWNSHIP 1.54
FAIRMOUNT ROAD 3.40
CHAGRIN FALLS 7.87
AURORA CENTRAL 2.98
AURORA CENTRAL LAND SITE
AUBURN TOWNSHIP 0.84
AUBURN TOWNSHIP LAND SITE
TROY TOWNSHIP LAND SITE
TROY TOWNSHIP
MANTUA 0.85
MANTUA LAND SITE
SHALERSBORO 2.00
SHALERSBORO LAND SITE
RAVENNA 12.34
RANDOLPH 0.75
RANDOLPH LAND SITE
LIVERPOOL 5.00
LIVERPOOL LAND SITE
HINCKLEY 1.72
HINCKLEY LAND SITE
UPPER EAST BRANCH 1.11
MEDINA COUNTY 5.00
MEDINA COUNTY LAND SITE
MALLET CREEK 0.60
NEW MEDINA LAND SITE
NEW MEDINA 0.49
LEGEND
COUNTY LINES
RIVERS & STREAMS
DIVIDE OF MAJOR RIVER BASINS
DIVIDE OF SUB DRAINAGE BASINS
EXISTING SEWAGE TREATMENT PLANT
PLAN "B" SEWAGE TREATMENT PLANT (WITH YEAR 2000 FLOW IN MGD)
SANITARY INTERCEPTOR
STORM RUNOFF DETENTION BASIN (EARTHEN)
STORM RUNOFF DETENTION BASIN (CONCRETE)
ADVANCED STORMWATER TREATMENT PLANT
FORCE MAINS TO LAND TREATMENT AREAS
LAND TREATMENT AREA WITH WINTER STORAGE RESERVOIR
SCALE
PLAN B

FIGURE IV-2

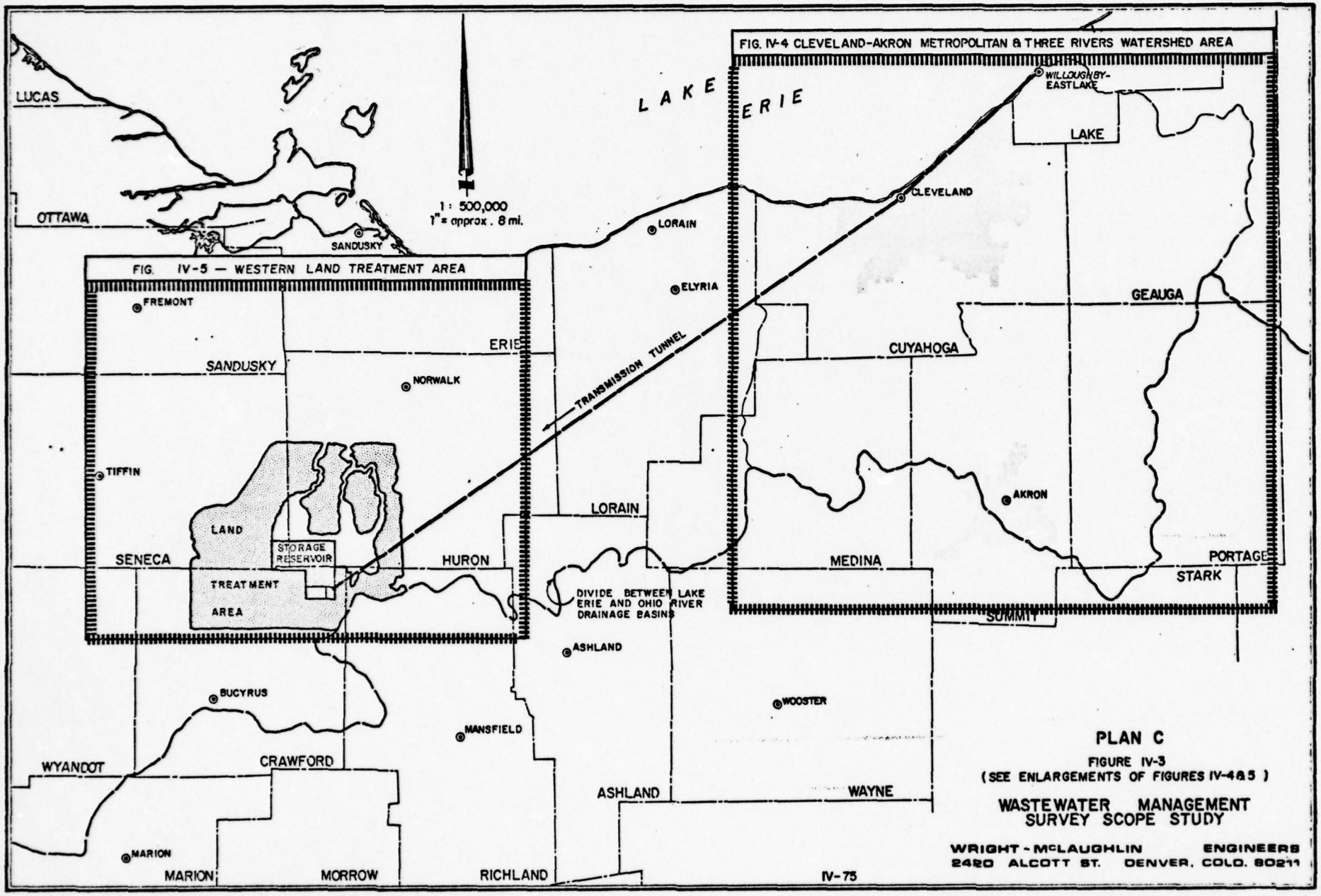
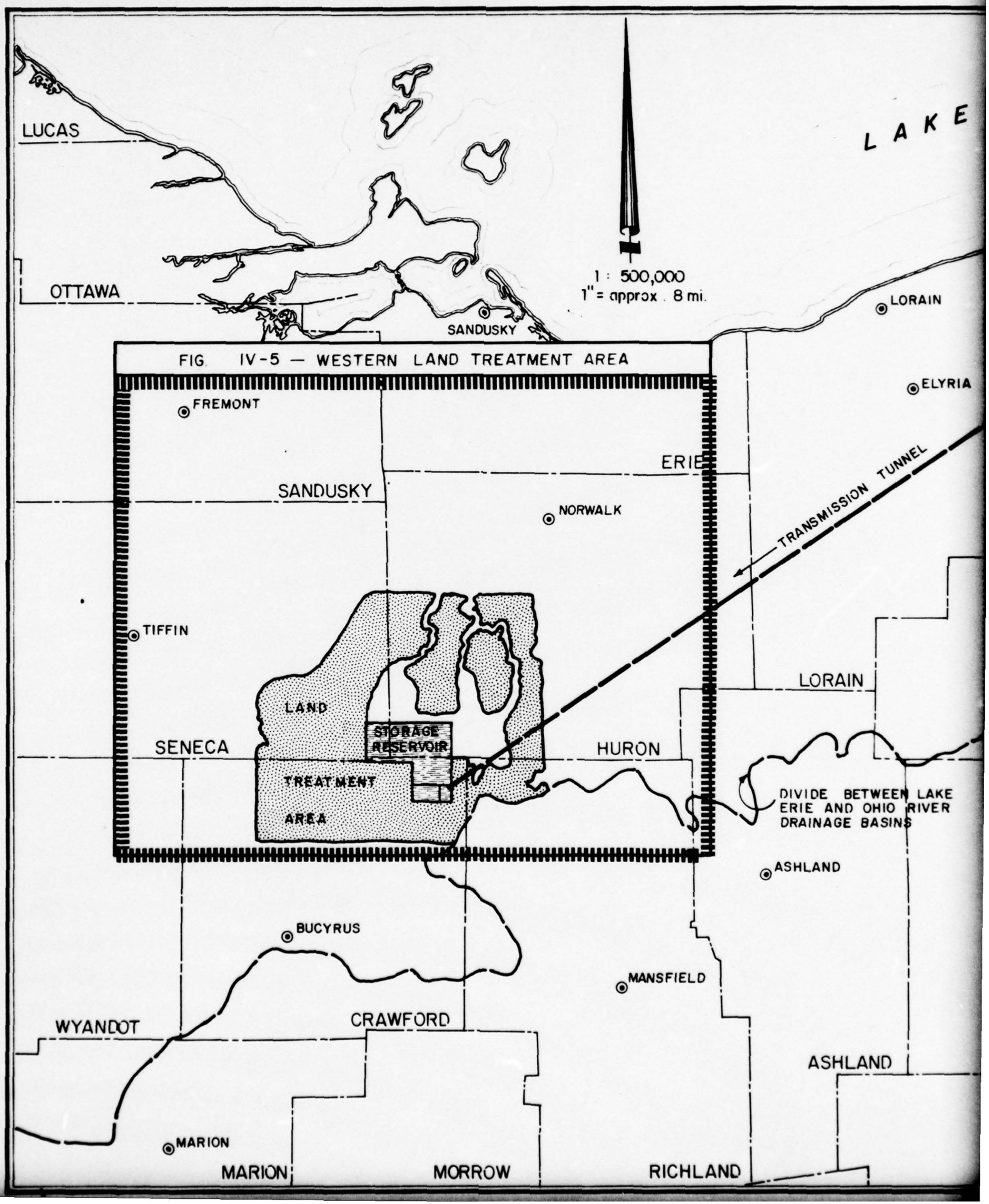


FIG. IV-4 CLEVELAND-AKRON METROPOLITAN & THREE RIVERS WATERSHED AREA
FIG. IV-5 — WESTERN LAND TREATMENT AREA
LAKE ERIE
1 : 500,000
1" = approx. 8 mi.
LUCAS
OTTAWA
SANDUSKY
FREMONT
SANDUSKY
ERIE
NORWALK
TIFFIN
SENECA
HURON
LAND TREATMENT AREA
STORAGE RESERVOIR
TRANSMISSION TUNNEL
LORAIN
ELYRIA
CLEVELAND
WILLOUGHBY-EASTLAKE
LAKE
GEAUGA
CUYAHOGA
AKRON
MEDINA
PORTAGE
STARK
SUMMIT
DIVIDE BETWEEN LAKE ERIE AND OHIO RIVER DRAINAGE BASINS
ASHLAND
WOOSTER
BUCYRUS
MANSFIELD
WYANDOT
CRAWFORD
ASHLAND
WAYNE
MARION
MARION
MORROW
RICHLAND
PLAN C
FIGURE IV-3
(SEE ENLARGEMENTS OF FIGURES IV-4&5)
WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
WRIGHT-McLAUGHLIN ENGINEERS
2420 ALCOTT ST. DENVER, COLO. 80211
IV-75


LUCAS
LAKE
OTTAWA
SANDUSKY
1 : 500,000
1" = approx. 8 mi.
LORAIN
FIG. IV-5 — WESTERN LAND TREATMENT AREA
ELYRIA
FREMONT
ERIE
SANDUSKY
NORWALK
TRANSMISSION TUNNEL
TIFFIN
LORAIN
LAND
STORAGE RESERVOIR
SENECA
HURON
TREATMENT AREA
DIVIDE BETWEEN LAKE ERIE AND OHIO RIVER DRAINAGE BASINS
ASHLAND
BUCYRUS
MANSFIELD
WYANDOT
CRAWFORD
ASHLAND
MARION
MARION
MORROW
RICHLAND

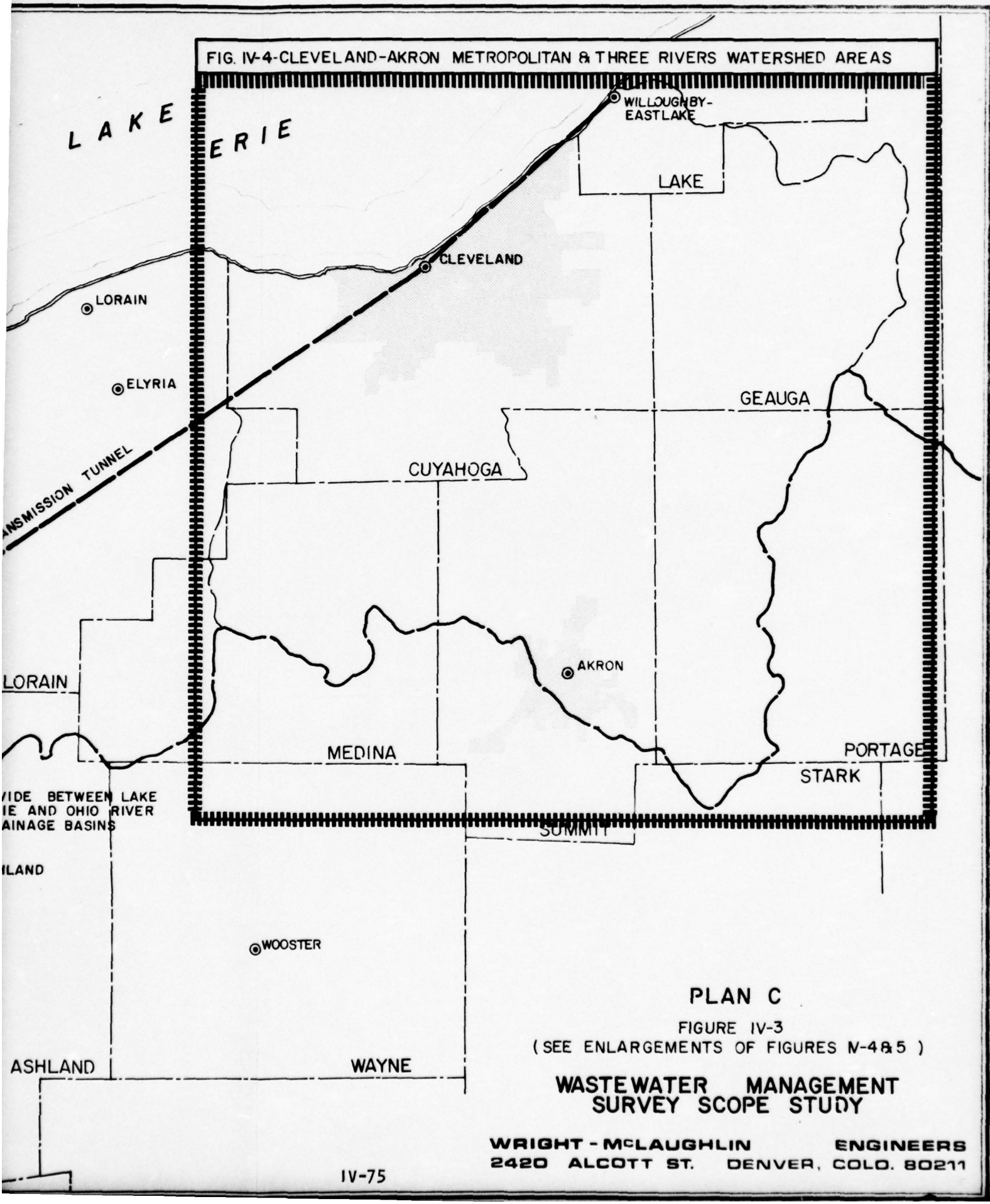


FIG. IV-4-CLEVELAND-AKRON METROPOLITAN & THREE RIVERS WATERSHED AREAS
LAKE ERIE
WILLOUGHBY-EASTLAKE
LAKE
CLEVELAND
LORAIN
ELYRIA
GEAUGA
CUYAHOGA
AKRON
MEDINA
PORTAGE
STARK
SUMMIT
WOOSTER
ASHLAND
WAYNE
PLAN C
FIGURE IV-3
(SEE ENLARGEMENTS OF FIGURES IV-4&5)
WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
WRIGHT-McLAUGHLIN ENGINEERS
2420 ALCOTT ST. DENVER, COLO. 80211

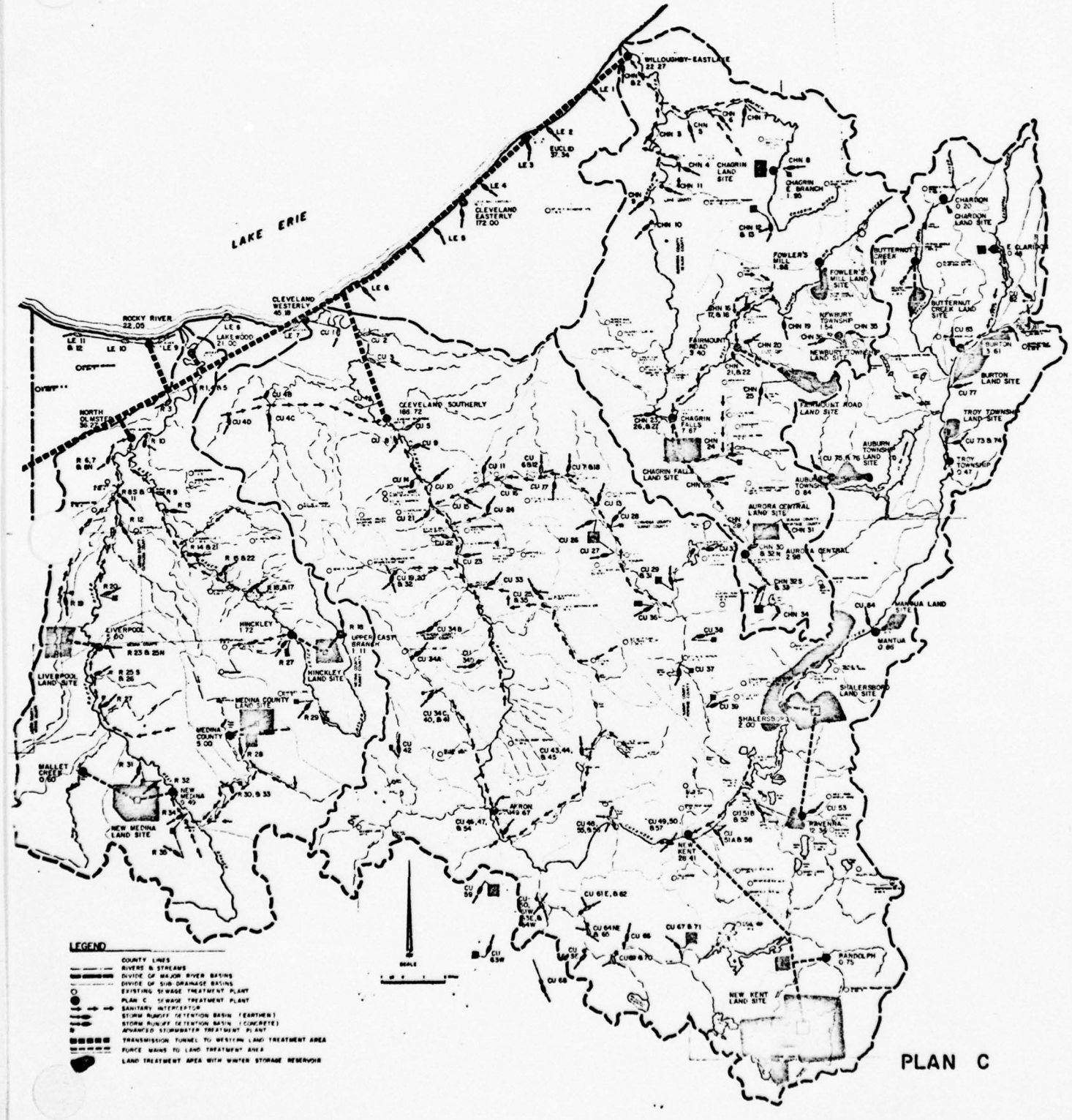
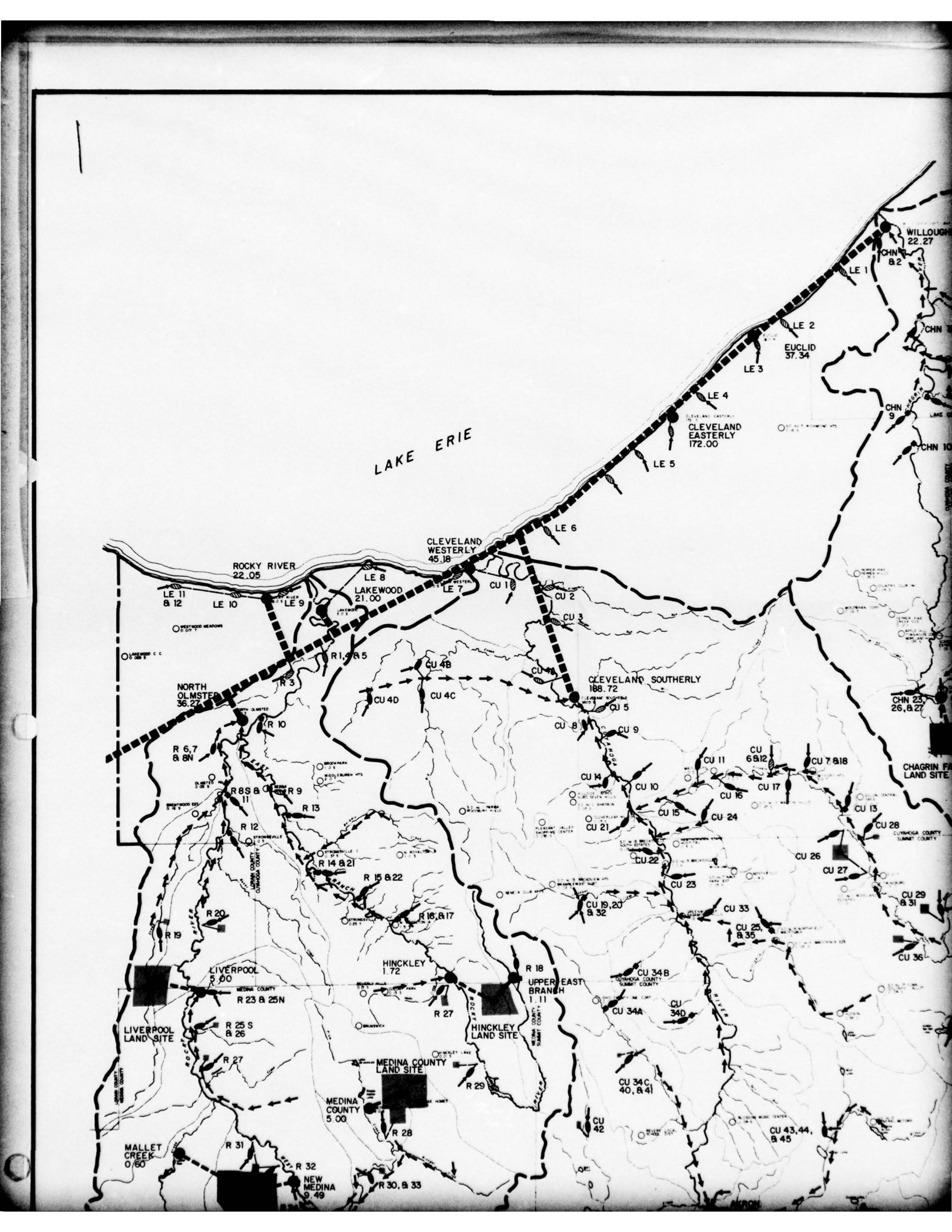
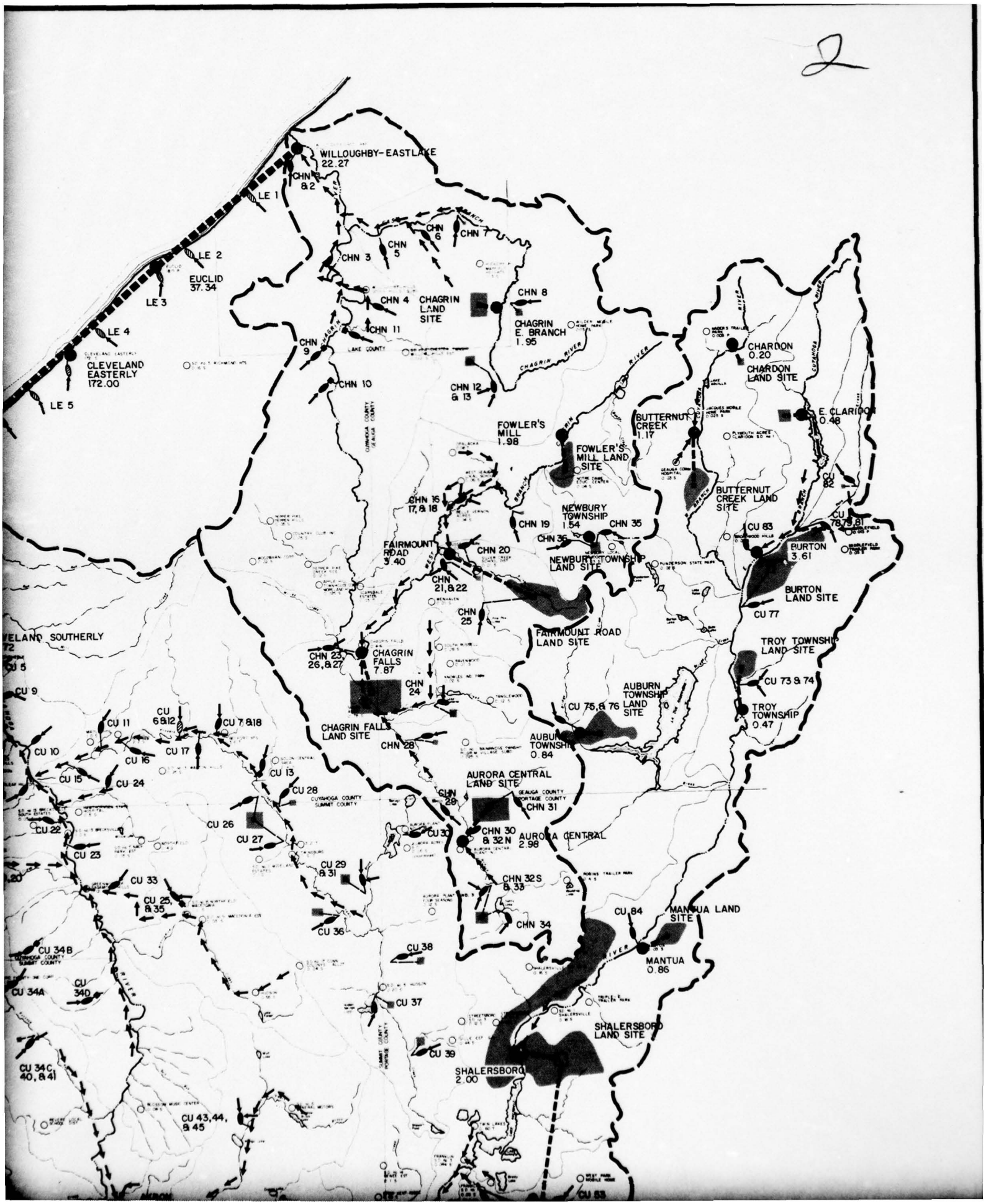
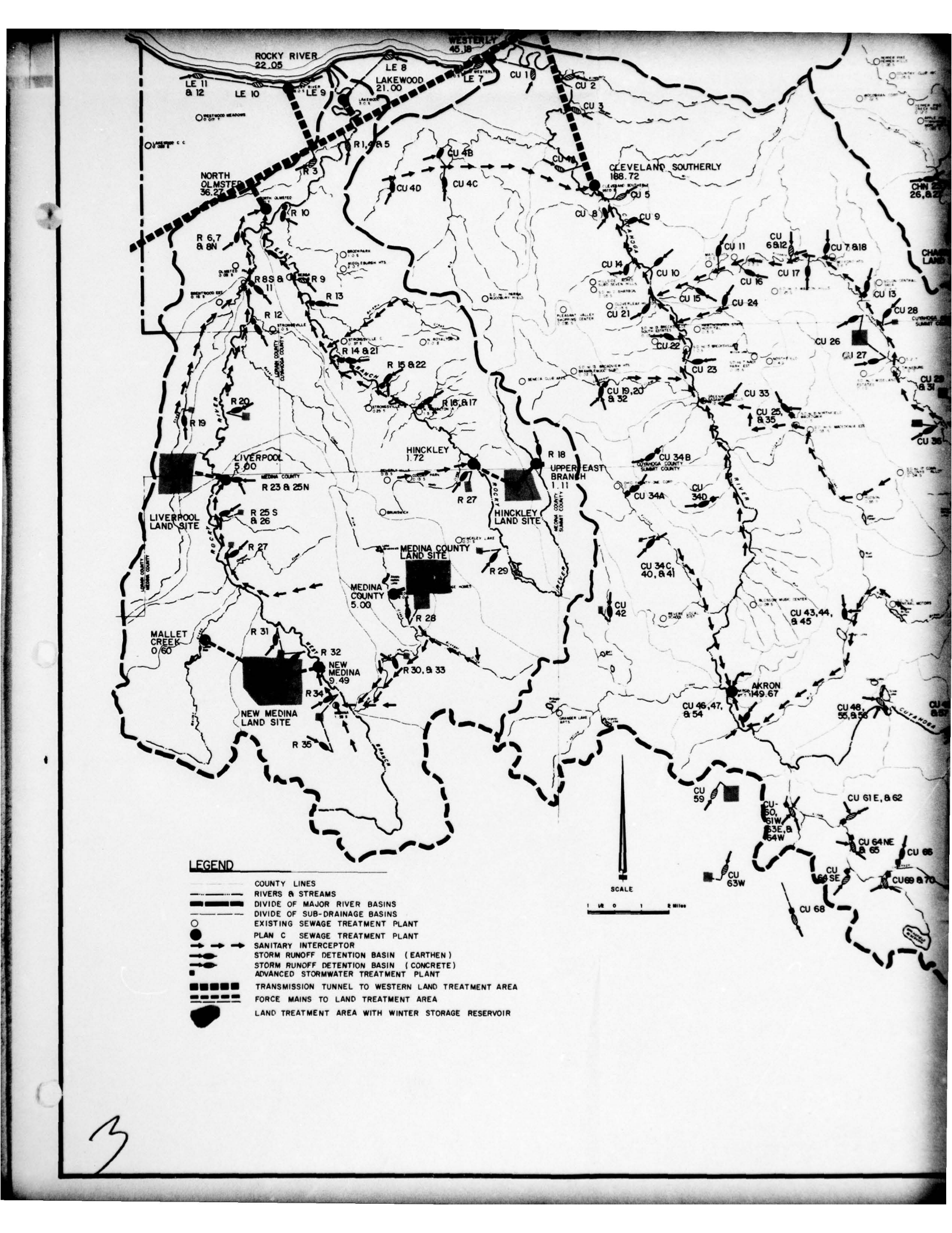

LAKE ERIE
WILLOUGHBY-EASTLAKE 22.27
EUCLID 37.54
CLEVELAND EASTERLY 172.00
CLEVELAND WESTERLY 45.19
ROCKY RIVER 22.05
LAKEWOOD 21.00
CLEVELAND SOUTHERLY 166.72
NORTH OLMSTED 36.72
CHAGRIN LAND SITE
CHAGRIN E. BRANCH 1.85
CHAGRIN FALLS 7.67
CHAGRIN FALLS LAND SITE
FOWLER'S MILL 1.88
FOWLER'S MILL LAND SITE
CHARDON 0.20
CHARDON LAND SITE
E. CLARIDON 5.48
BUTTERNUT CREEK 1.17
BUTTERNUT CREEK LAND SITE
NEWBURY TOWNSHIP 1.54
NEWBURY TOWNSHIP LAND SITE
FAIRMOUNT ROAD 9.40
FAIRMOUNT ROAD LAND SITE
BURTON 3.61
BURTON LAND SITE
TROY TOWNSHIP LAND SITE
TROY TOWNSHIP 0.47
AUBURN TOWNSHIP LAND SITE
AUBURN TOWNSHIP 0.84
AURORA CENTRAL LAND SITE
AURORA CENTRAL 2.98
MANTUA LAND SITE
MANTUA 0.86
SHALERSBORO LAND SITE
SHALERSBORO 2.00
RAVENNA 12.36
NEW KENT 29.41
NEW KENT LAND SITE
RANDOLPH 0.73
AKRON 349.67
HINCKLEY 1.72
HINCKLEY LAND SITE
UPPER EAST BRANCH 1.11
LIVERPOOL 2.00
LIVERPOOL LAND SITE
MEDINA COUNTY LAND SITE
MEDINA COUNTY 5.00
MALLET CREEK 0.65
NEW MEDINA 0.49
NEW MEDINA LAND SITE
LEGEND
COUNTY LINES
RIVERS & STREAMS
DIVIDE OF MAJOR RIVER BASINS
DIVIDE OF SUB DRAINAGE BASINS
EXISTING SEWAGE TREATMENT PLANT
PLAN C SEWAGE TREATMENT PLANT
SANITARY INTERCEPTOR
STORM RUNOFF DETENTION BASIN (EARTHEN)
STORM RUNOFF DETENTION BASIN (CONCRETE)
ADVANCED STORMWATER TREATMENT PLANT
TRANSMISSION TUNNEL TO WESTERN LAND TREATMENT AREA
FORCE MAINS TO LAND TREATMENT AREA
LAND TREATMENT AREA WITH WINTER STORAGE RESERVOIR
SCALE
PLAN C

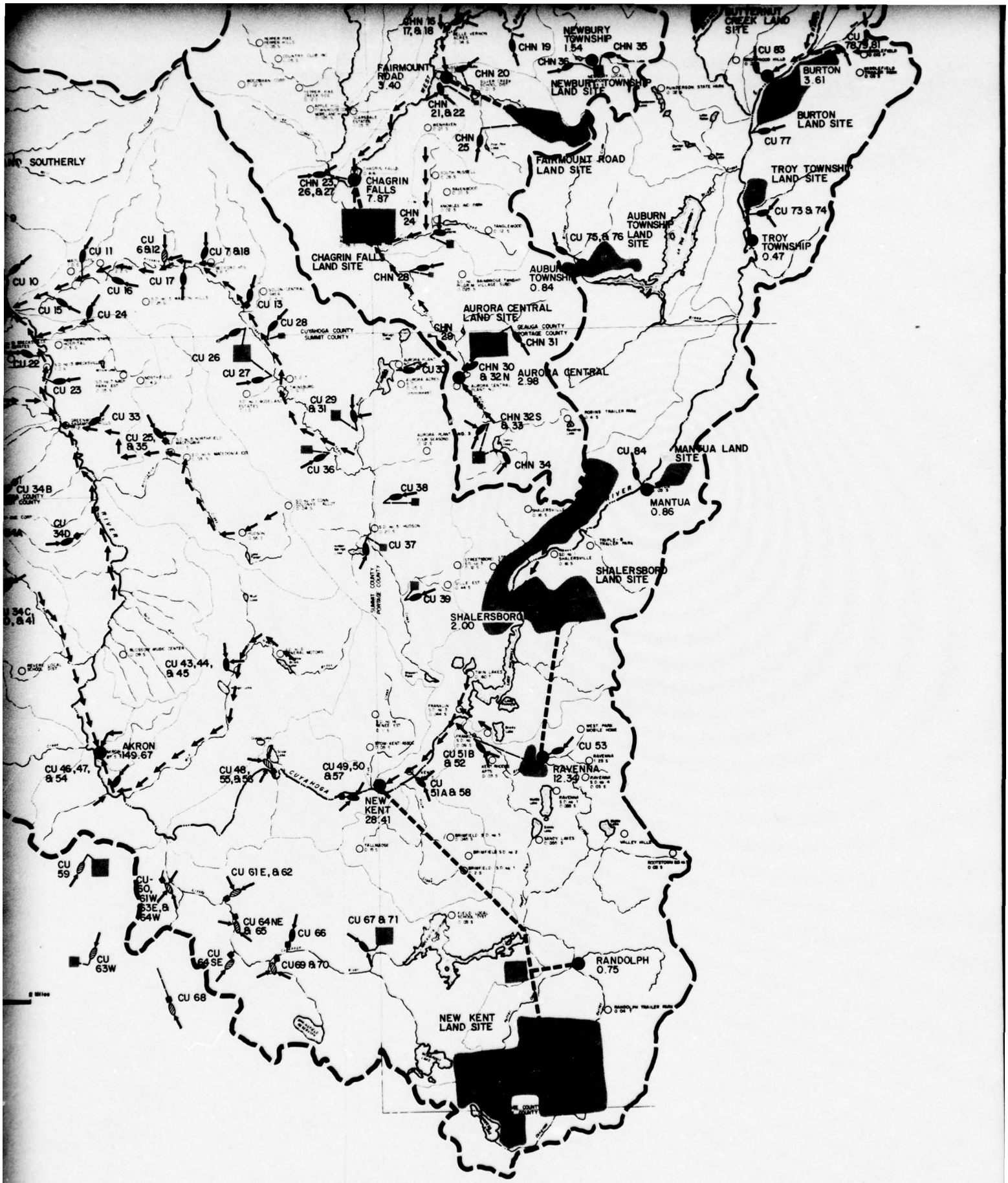
FIGURE IV-4


LAKE ERIE
WILLOUGH
22.27
CHN 8 2
LE 1
LE 2
EUCLID
37.34
LE 3
LE 4
CLEVELAND
EASTERLY
172.00
LE 5
LE 6
CHN 9
CHN 10
CLEVELAND
WESTERLY
45.18
ROCKY RIVER
22.05
LE 8
LE 7
CU 1
CU 2
CU 3
LE 11
& 12
LE 10
LE 9
LAKEWOOD
21.00
R 1, & 5
R 3
CU 4B
CU 4A
CU 4D
CU 4C
NORTH
OLMSTED
36.27
CLEVELAND SOUTHERLY
188.72
CU 5
CHN 23
26, & 27
R 10
CU 8
CU 9
R 6,7
& 8N
CU 11
CU
6 & 12
CU 7 & 18
CHAGRIN FA
LAND SITE
CU 14
CU 10
CU 16
CU 17
R 8S & 11
R 9
R 13
CU 15
CU 24
CU 21
CU 13
CU 28
R 12
CU 26
CU 27
CU 22
R 14 & 21
R 15 & 22
CU 23
CU 29
& 31
CU 19, 20
& 32
CU 33
R 20
R 19
R 16, & 17
CU 25
& 35
CU 36
HINCKLEY
1.72
R 18
UPPER EAST
BRANCH
1.11
LIVERPOOL
5.00
CU 34B
R 23 & 25N
R 27
CU 34A
CU
34D
LIVERPOOL
LAND SITE
R 25 S
& 26
HINCKLEY
LAND SITE
R 27
MEDINA COUNTY
LAND SITE
CU 34C
40, & 41
R 29
MEDINA
COUNTY
5.00
R 28
CU
42
CU 43, 44,
& 45
MALLET
CREEK
0.60
R 31
R 32
NEW
MEDINA
9.49
R 30, & 33
AKRON


2
WILLOUGHBY-EASTLAKE 22.27
CHN 1 & 2
LE 1
LE 2
EUCLID 37.34
LE 3
LE 4
LE 5
CLEVELAND EASTERLY 172.00
CHN 3
CHN 4
CHAGRIN LAND SITE
CHN 5
CHN 6
CHN 7
CHN 8
CHAGRIN E. BRANCH 1.95
CHN 9
CHN 10
CHN 11
CHN 12 & 13
FOWLER'S MILL 1.98
FOWLER'S MILL LAND SITE
BUTTERNUT CREEK 1.17
CHARDON 0.20
CHARDON LAND SITE
E. CLARIDON 0.48
BUTTERNUT CREEK LAND SITE
CU 82
CHN 16, 17, & 18
NEWBURY TOWNSHIP 1.54
CHN 19
CHN 35
CU 83
CU 78, 79, 81
BURTON 3.61
FAIRMOUNT ROAD 3.40
CHN 20
NEWBURY TOWNSHIP LAND SITE
CHN 21, & 22
BURTON LAND SITE
CHN 25
CU 77
FAIRMOUNT ROAD LAND SITE
TROY TOWNSHIP LAND SITE
CHN 23, 26, & 27
CHAGRIN FALLS 7.87
CHN 24
CU 73 & 74
AUBURN TOWNSHIP LAND SITE
CU 75, & 76
TROY TOWNSHIP 0.47
CU 9
CU 11
CU 6 & 12
CU 7 & 18
CU 10
CU 16
CU 17
CHAGRIN FALLS LAND SITE
CHN 28
AUBURN TOWNSHIP 0.84
CU 15
CU 24
CU 13
CU 28
AURORA CENTRAL LAND SITE
CHN 29
CHN 31
CU 22
CU 26
CU 27
CU 30
CHN 30 & 32 N
AURORA CENTRAL 2.98
CU 23
CU 29 & 31
CU 33
CHN 32 S & 33
CU 25, & 35
CU 36
CU 84
MANTUA LAND SITE
CHN 34
CU 38
MANTUA 0.86
CU 34 B
CU 34 A
CU 34 D
CU 37
SHALERSBORO LAND SITE
CU 39
SHALERSBORO 2.00
CU 34 C, 40, & 41
CU 43, 44, & 45
CU 53

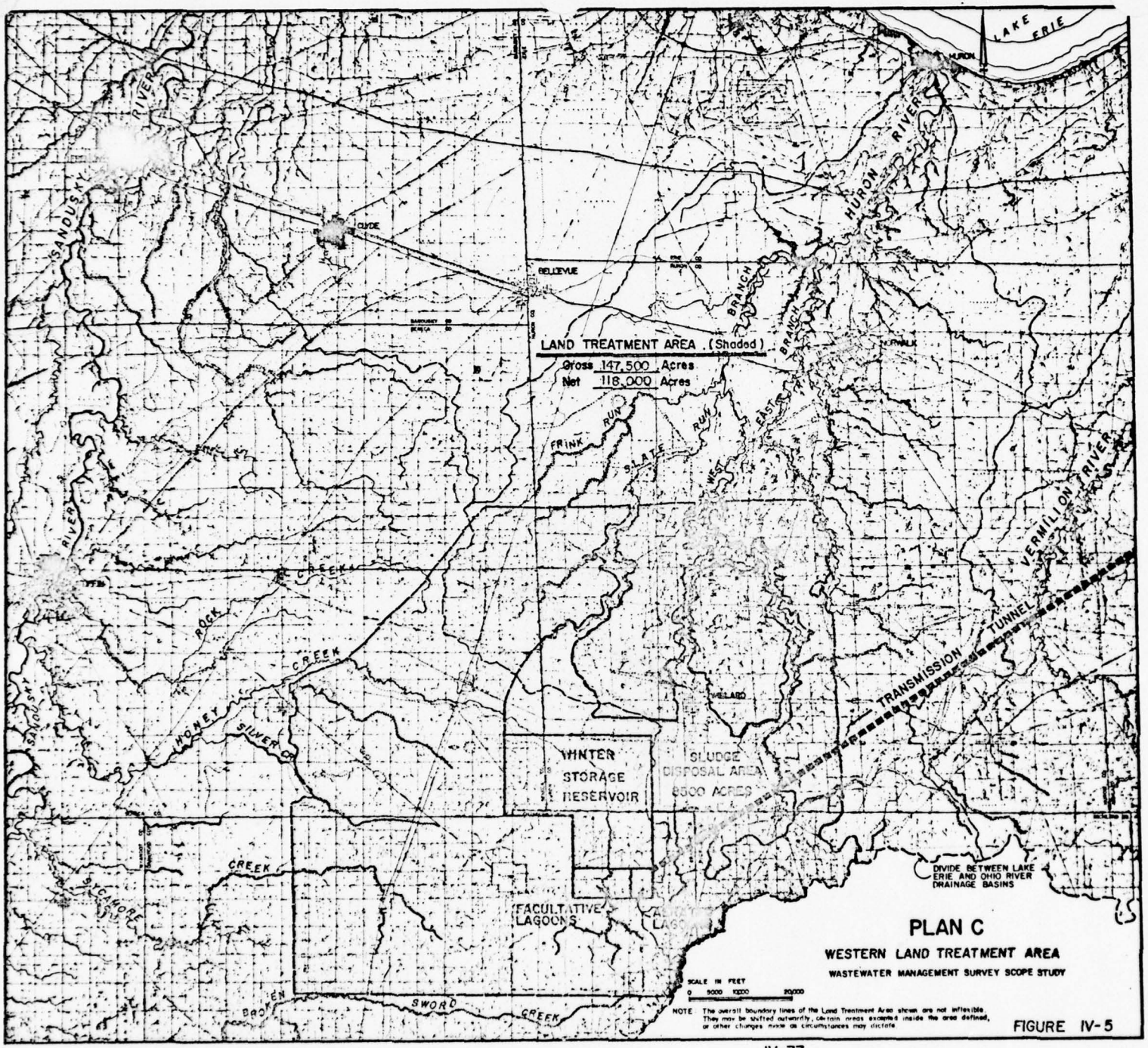

ROCKY RIVER
22.05
WESTERLY
45.18
LAKEWOOD
21.00
LE 11
& 12
LE 10
LE 9
LE 8
LE 7
CU 1
CU 2
CU 3
CU 4B
CU 4A
CU 4C
CU 4D
CLEVELAND SOUTHERLY
188.72
CU 5
CU 8
CU 9
NORTH
OLMSTED
36.27
R 1,2 & 5
R 3
R 10
R 6,7
& 8N
R 8S & 9
11
R 12
R 13
R 14 & 21
R 15 & 22
R 16,& 17
R 18
R 19
R 20
CU 11
CU
6 & 12
CU 7 & 18
CU 14
CU 10
CU 16
CU 17
CU 15
CU 24
CU 21
CU 13
CU 28
CU 22
CU 26
CU 27
CU 23
CU 19,20
& 32
CU 33
CU 25,
& 35
CU 36
CU 29
& 31
LIVERPOOL
5.00
R 23 & 25N
HINCKLEY
1.72
HINCKLEY
LAND SITE
UPPER EAST
BRANCH
1.11
CU 34B
CU 34A
CU
34D
LIVERPOOL
LAND SITE
R 25 S
& 26
R 27
R 29
MEDINA COUNTY
LAND SITE
MEDINA
COUNTY
5.00
R 28
CU 34C,
40, & 41
CU
42
CU 43,44,
& 45
MALLET
CREEK
0.60
R 31
R 32
NEW
MEDINA
5.49
R 34
R 30, & 33
NEW MEDINA
LAND SITE
R 35
AKRON
149.67
CU 46,47,
& 54
CU 48,
55, & 56
CU
59
CU-
60,
61W
63E, &
64W
CU 61E, & 62
CU 64NE
& 65
CU 66
CU
63W
CU
69SE
CU 69 & 70
CU 68
SCALE
1/2 0 1 2 Miles
LEGEND
COUNTY LINES
RIVERS & STREAMS
DIVIDE OF MAJOR RIVER BASINS
DIVIDE OF SUB-DRAINAGE BASINS
EXISTING SEWAGE TREATMENT PLANT
PLAN C SEWAGE TREATMENT PLANT
SANITARY INTERCEPTOR
STORM RUNOFF DETENTION BASIN (EARTHEN)
STORM RUNOFF DETENTION BASIN (CONCRETE)
ADVANCED STORMWATER TREATMENT PLANT
TRANSMISSION TUNNEL TO WESTERN LAND TREATMENT AREA
FORCE MAINS TO LAND TREATMENT AREA
LAND TREATMENT AREA WITH WINTER STORAGE RESERVOIR

3



PLAN C

FIGURE IV-4

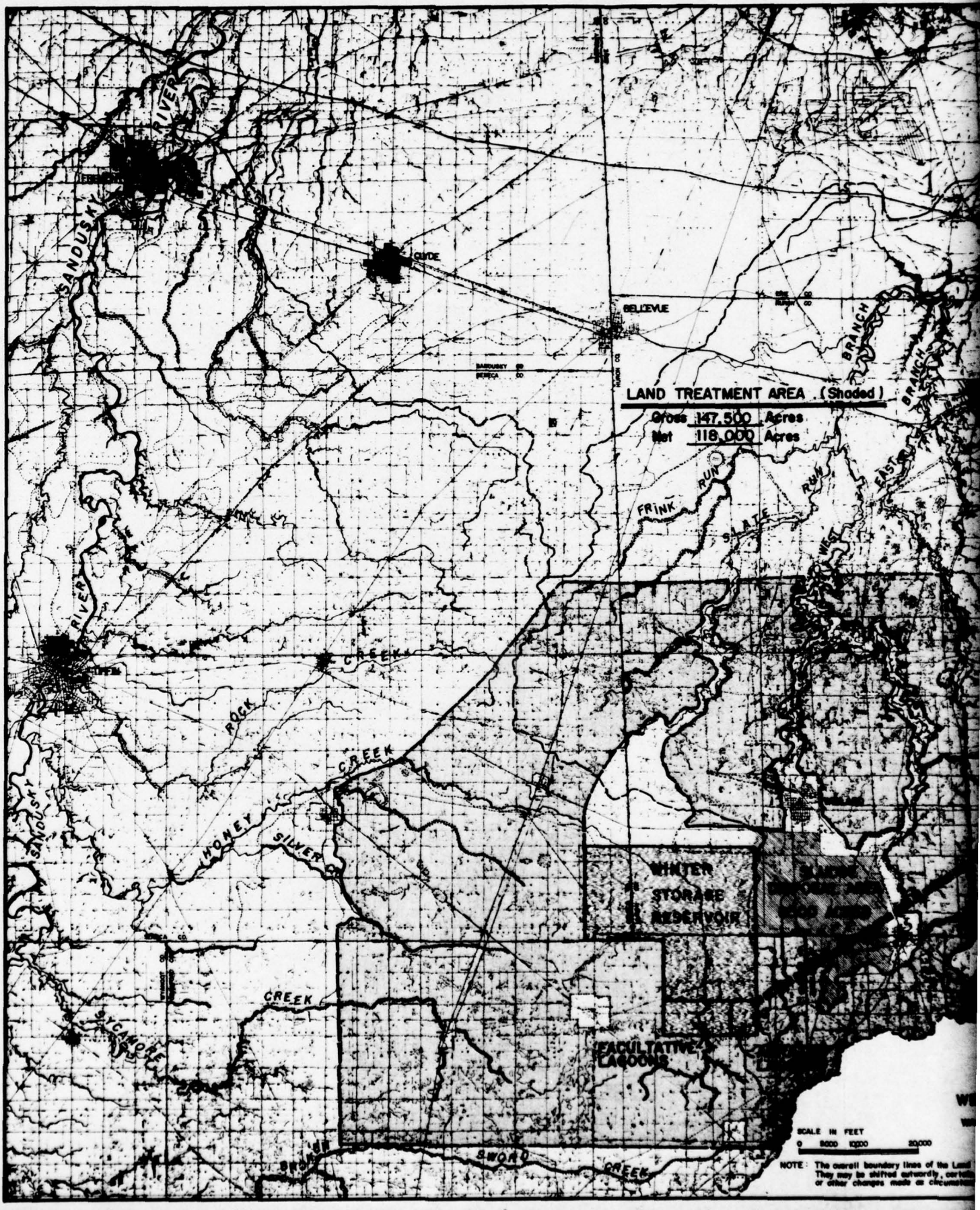


PLAN C

WESTERN LAND TREATMENT AREA

WASTEWATER MANAGEMENT SURVEY SCOPE STUDY

FIGURE IV-5


SANDUSKY RIVER
GUDE
BELLEVUE
BRANCH
BRANCH
LAND TREATMENT AREA (Shaded)
Gross 147,500 Acres
Net 118,000 Acres
FRINK
RUN
EAST
RUN
WEST
SLATE
RIVER
CREEK
ROCK
CREEK
SANDUSKY
HONEY
SILVER
WINTER
STORAGE
RESERVOIR
CREEK
SYCAMORE
FACULTATIVE
LAGOONS
SWORD
CREEK
SCALE IN FEET
0 5000 10000 20000
NOTE: The overall boundary lines of the Land
They may be shifted outwardly, certain
or other changes made as circumstance

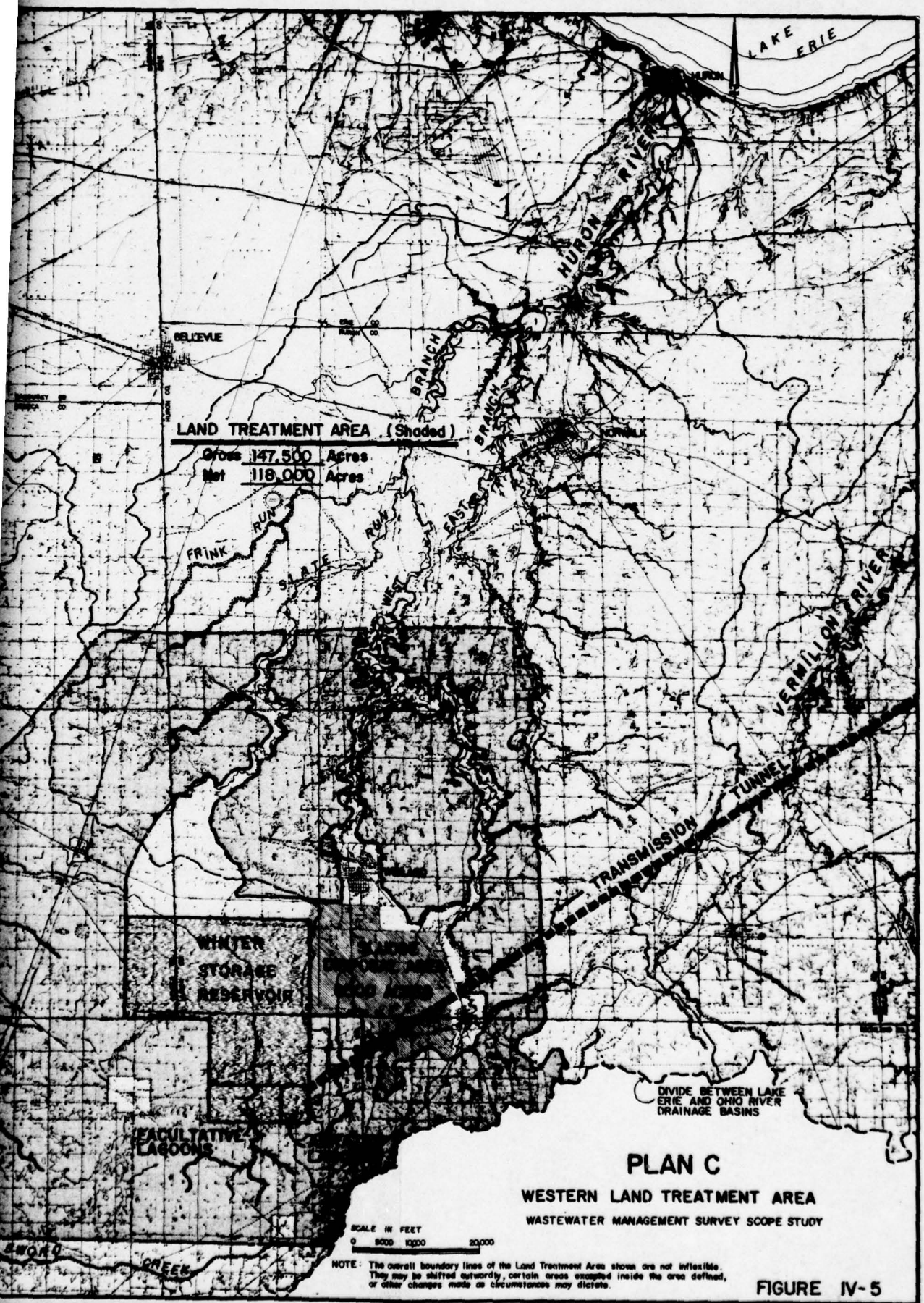

LAKE ERIE
HURON
HURON RIVER
BELLEVUE
BRANCH
EAST BRANCH
NORWALK
LAND TREATMENT AREA (Shaded)
Gross 147,500 Acres
Net 118,000 Acres
FRINK
RUN
SLATE
RUN
WEST
EAST
VERMILION RIVER
TUNNEL
TRANSMISSION
WINTER
STORAGE
RESERVOIR
FACULTATIVE
LAGOONS
DIVIDE BETWEEN LAKE ERIE AND OHIO RIVER DRAINAGE BASINS
PLAN C
WESTERN LAND TREATMENT AREA
WASTEWATER MANAGEMENT SURVEY SCOPE STUDY
SCALE IN FEET
0 5000 10000 20,000
NOTE: The overall boundary lines of the Land Treatment Area shown are not inflexible. They may be shifted outwardly, certain areas excepted inside the area defined, or other changes made as circumstances may dictate.

FIGURE IV-5

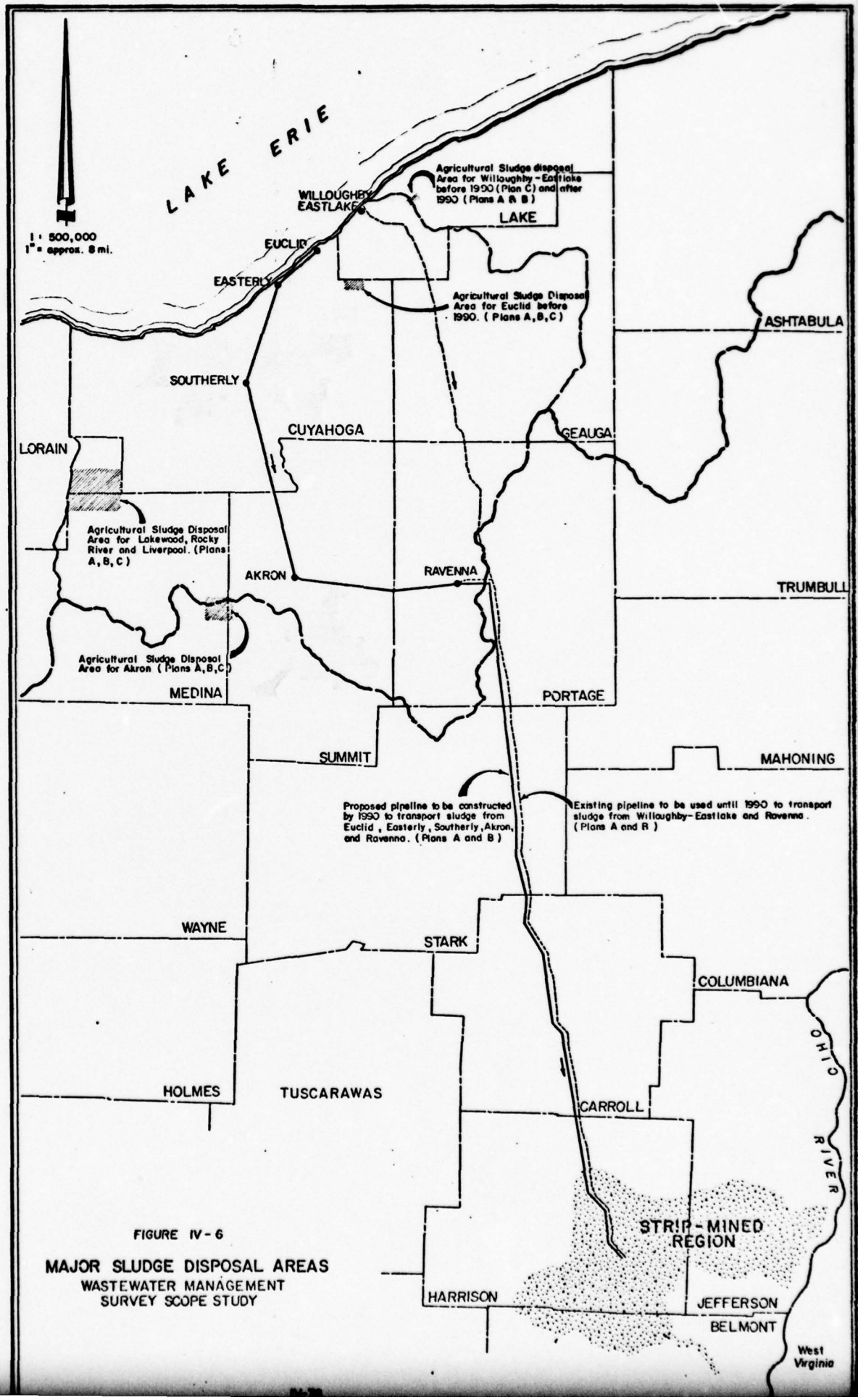
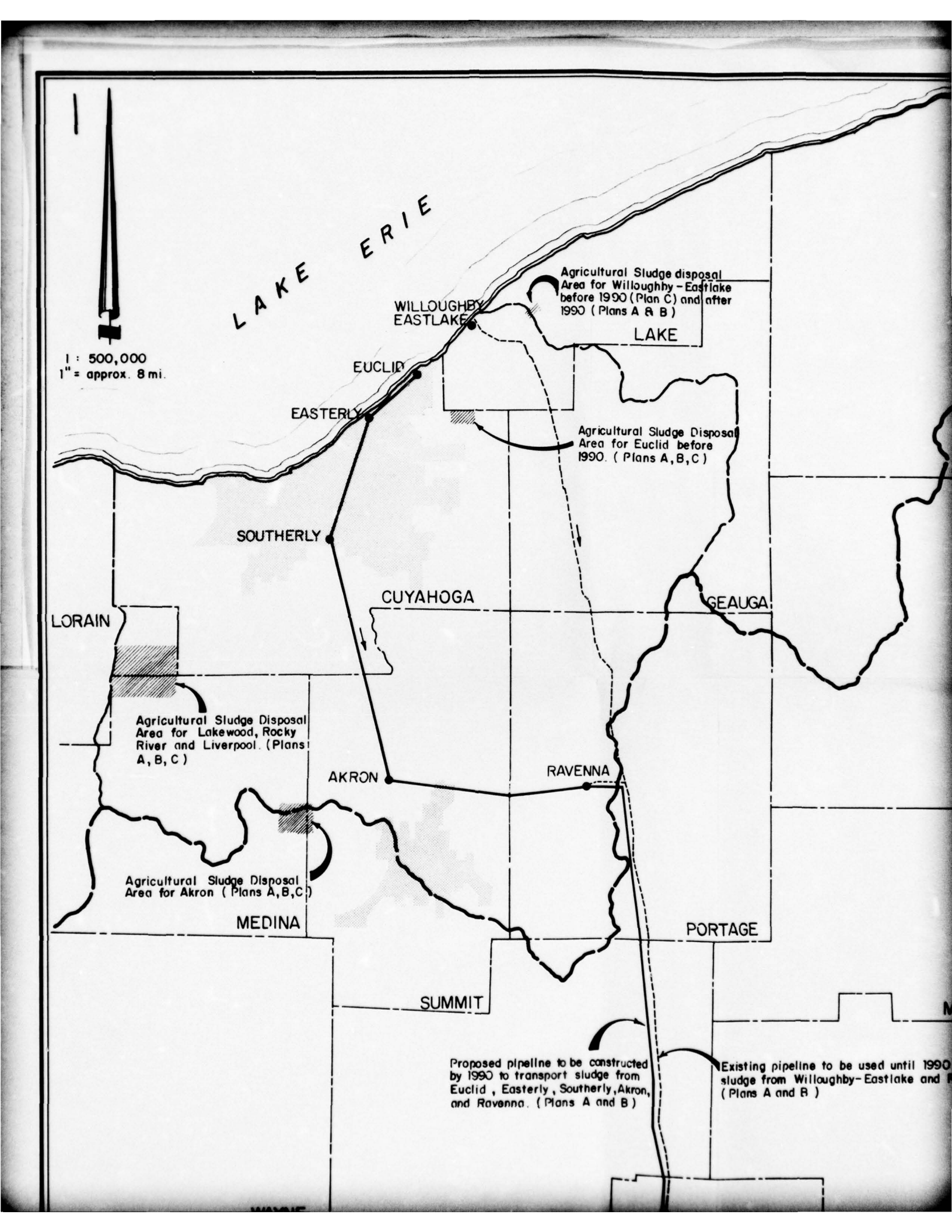
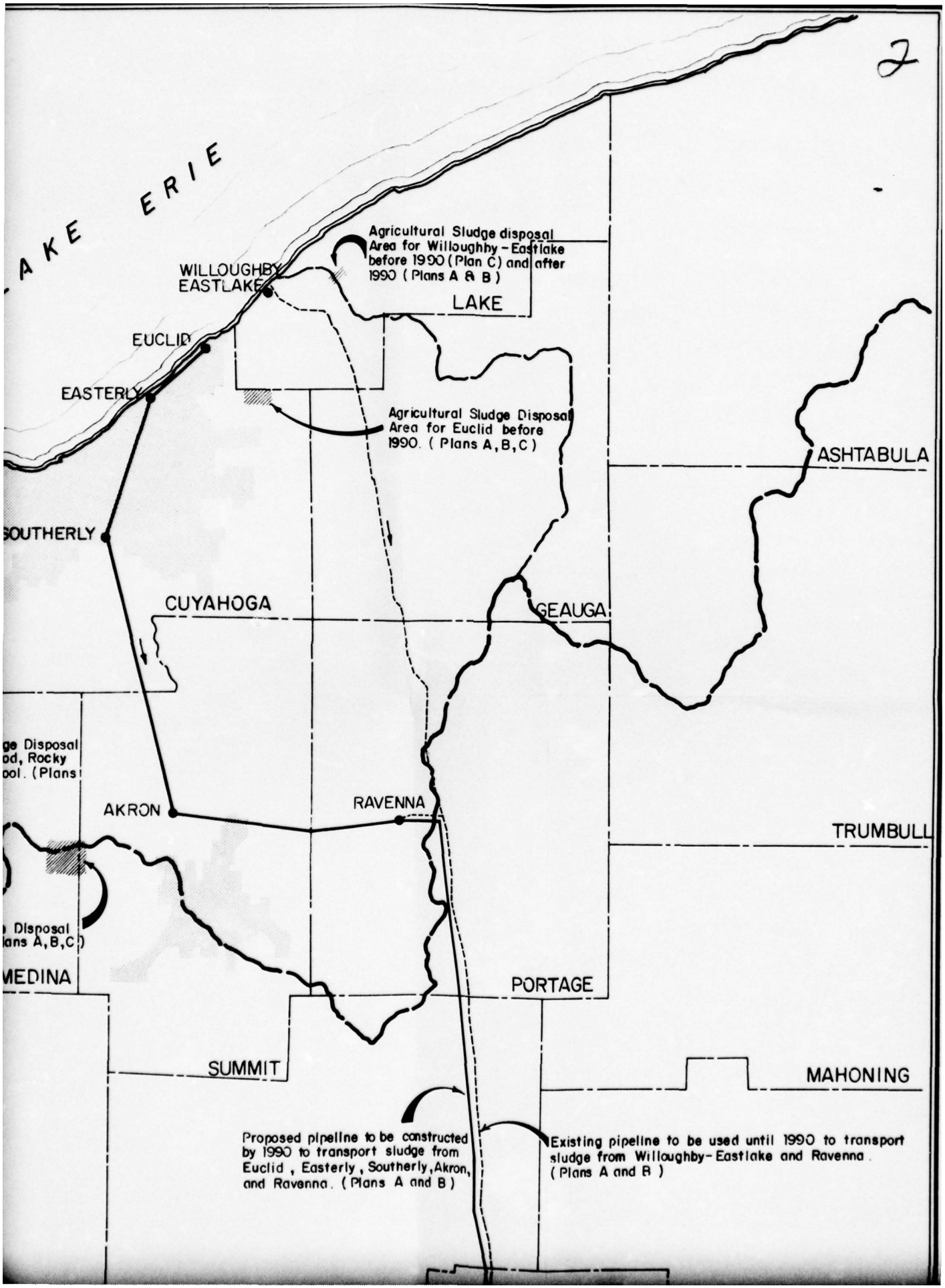


FIGURE IV-6

MAJOR SLUDGE DISPOSAL AREAS
WASTEWATER MANAGEMENT
SURVEY SCOPE STUDY


LAKE ERIE
1 : 500,000
1" = approx. 8 mi.
WILLOUGHBY
EASTLAKE
LAKE
Agricultural Sludge disposal Area for Willoughby - Eastlake before 1990 (Plan C) and after 1990 (Plans A & B)
EUCLID
EASTERLY
Agricultural Sludge Disposal Area for Euclid before 1990. (Plans A, B, C)
SOUTHERLY
CUYAHOGA
GEAUGA
LORAIN
Agricultural Sludge Disposal Area for Lakewood, Rocky River and Liverpool. (Plans A, B, C)
AKRON
RAVENNA
Agricultural Sludge Disposal Area for Akron (Plans A, B, C)
MEDINA
PORTAGE
SUMMIT
Proposed pipeline to be constructed by 1990 to transport sludge from Euclid , Easterly , Southerly, Akron, and Ravenna. (Plans A and B)
Existing pipeline to be used until 1990 sludge from Willoughby-Eastlake and
(Plans A and B)


2
LAKE ERIE
WILLOUGHBY
EASTLAKE
EUCLID
EASTERLY
SOUTHERLY
Agricultural Sludge disposal Area for Willoughby - Eastlake before 1990 (Plan C) and after 1990 (Plans A & B)
LAKE
Agricultural Sludge Disposal Area for Euclid before 1990. (Plans A, B, C)
ASHTABULA
CUYAHOGA
GEAUGA
AKRON
RAVENNA
TRUMBULL
PORTAGE
SUMMIT
MAHONING
Proposed pipeline to be constructed by 1990 to transport sludge from Euclid , Easterly , Southerly, Akron, and Ravenna. (Plans A and B)
Existing pipeline to be used until 1990 to transport sludge from Willoughby - Eastlake and Ravenna. (Plans A and B)

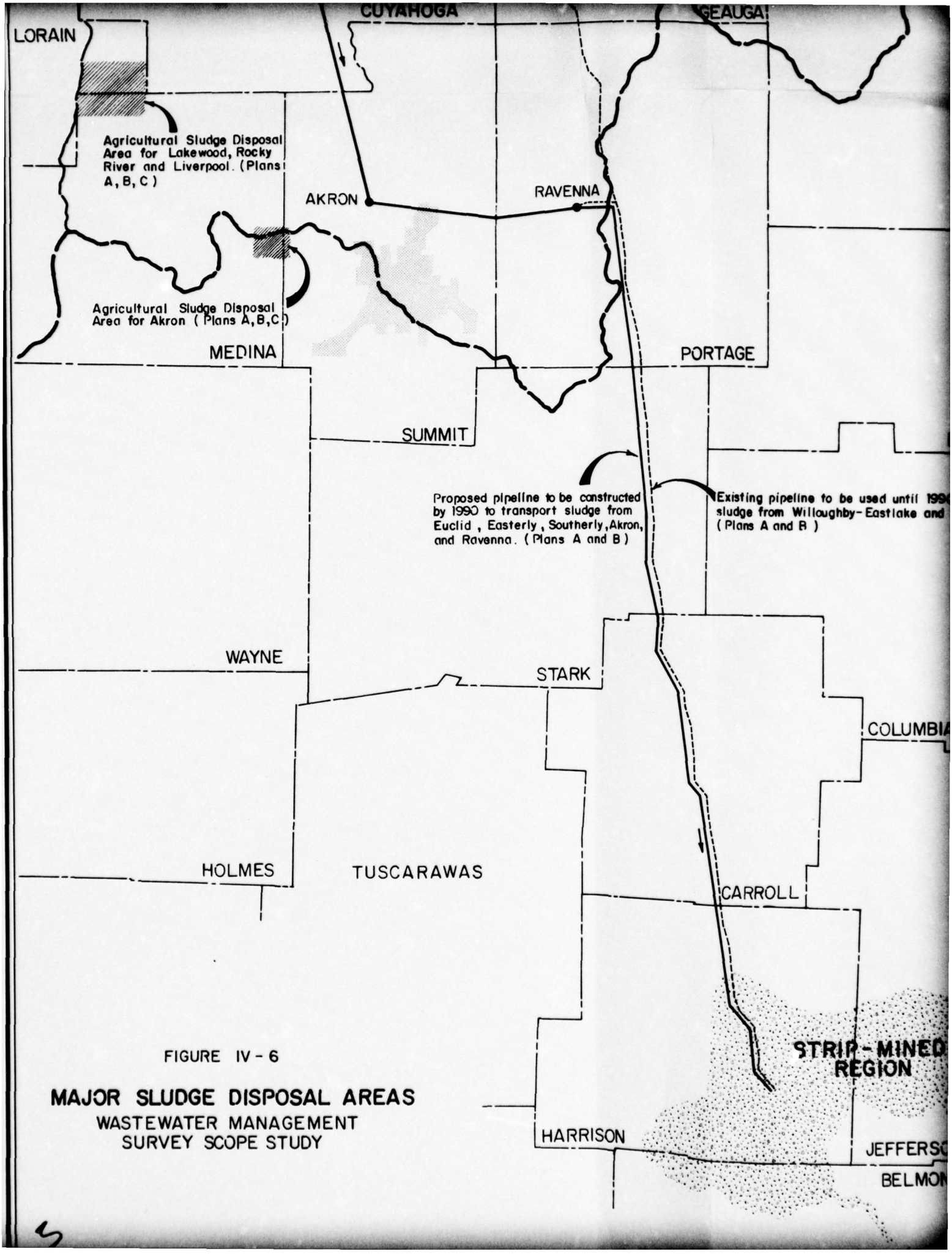
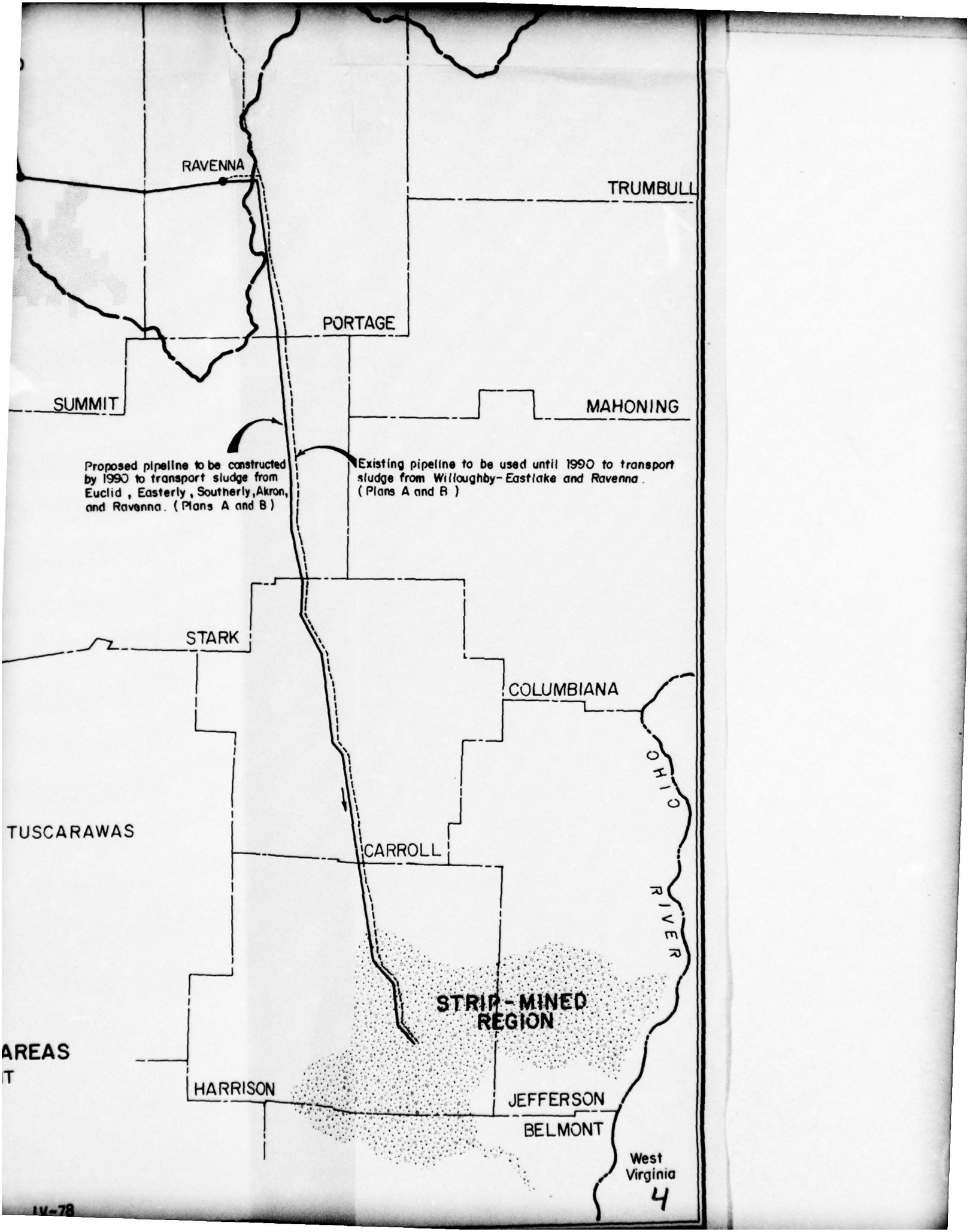


FIGURE IV - 6

MAJOR SLUDGE DISPOSAL AREAS

WASTEWATER MANAGEMENT
SURVEY SCOPE STUDY


RAVENNA
TRUMBULL
PORTAGE
SUMMIT
MAHONING
Proposed pipeline to be constructed by 1990 to transport sludge from Euclid , Easterly , Southerly, Akron, and Ravenna. (Plans A and B)
Existing pipeline to be used until 1990 to transport sludge from Willoughby-Eastlake and Ravenna. (Plans A and B)
STARK
COLUMBIANA
OHIO
TUSCARAWAS
CARROLL
RIVER
STRIP-MINED REGION
AREAS
T
HARRISON
JEFFERSON
BELMONT
West Virginia
4

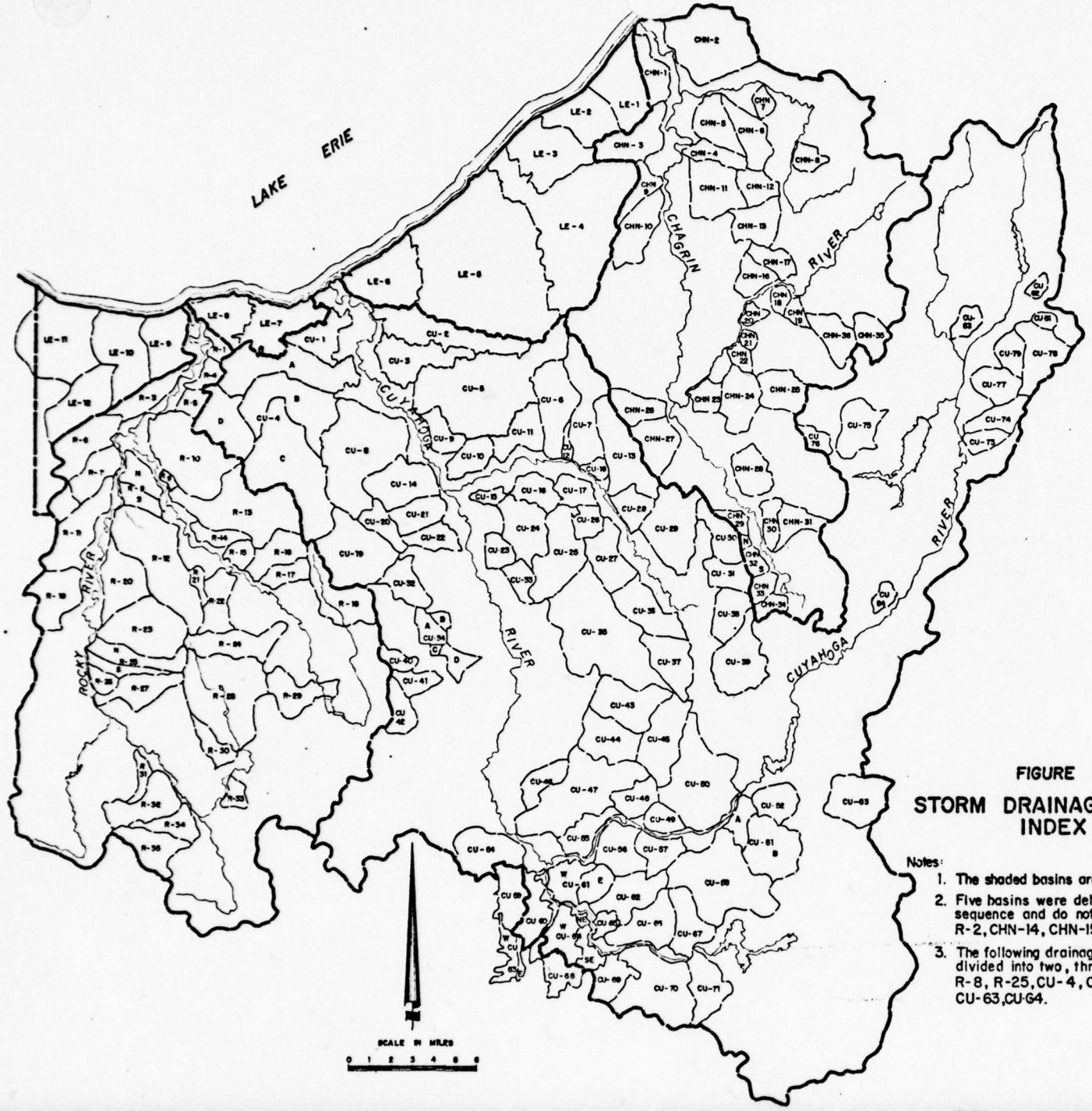


FIGURE IV-7

STORM DRAINAGE DISTRICTS INDEX MAP

Notes:

1. The shaded basins are combined sewer systems
2. Five basins were deleted from the numbering sequence and do not appear on this map: R-2, CHN-14, CHN-15, CU-72, and CU-80.
3. The following drainage basins have been subdivided into two, three or four parts: CHN-32, R-8, R-25, CU-4, CU-34, CU-51, CU-61, CU-63, CU-64.


LAKE ERIE
CHN-1
CHN-2
CHN-3
CHN-4
CHN-5
CHN-9
CHN-10
CHN-11
CHN-26
CHN-27
CHN 23
LE-1
LE-2
LE-3
LE-4
LE-5
LE-6
LE-7
LE-8
LE-9
LE-10
LE-11
LE-12
CU-1
CU-2
CU-3
CU-4
CU-5
CU-6
CU-7
CU-8
CU-9
CU-10
CU-11
CU 12
CU-13
CU-14
CU-15
CU-16
CU-17
CU-18
CU-19
CU-20
CU-21
CU-22
CU-23
CU-24
CU-25
CU-26
CU-27
CU-28
CU-29
CU-32
CU-33
CU-34
CU-35
CU-36
CU-37
CU-40
CU-41
CU 42
CU-43
CU-44
CU-45
CU-46
CU-47
CU-48
CU-49
CU-50
CU-55
CU-56
CU-57
CU-61
CU-62
CU 63
CU-64
R-1
R-2
R-3
R-4
R-5
R-6
R-7
R-8
R-9
R-10
R-11
R-12
R-13
R-14
R-15
R-16
R-17
R-18
R-19
R-20
R 21
R-22
R-23
R-24
R-25
R-26
R-27
R-28
R-29
R-30
R 31
R-32
R-33
R-34
R-35
A
B
C
D
N
S
W
E
CUYAHOGA RIVER
ROCKY RIVER
CHAGRIN

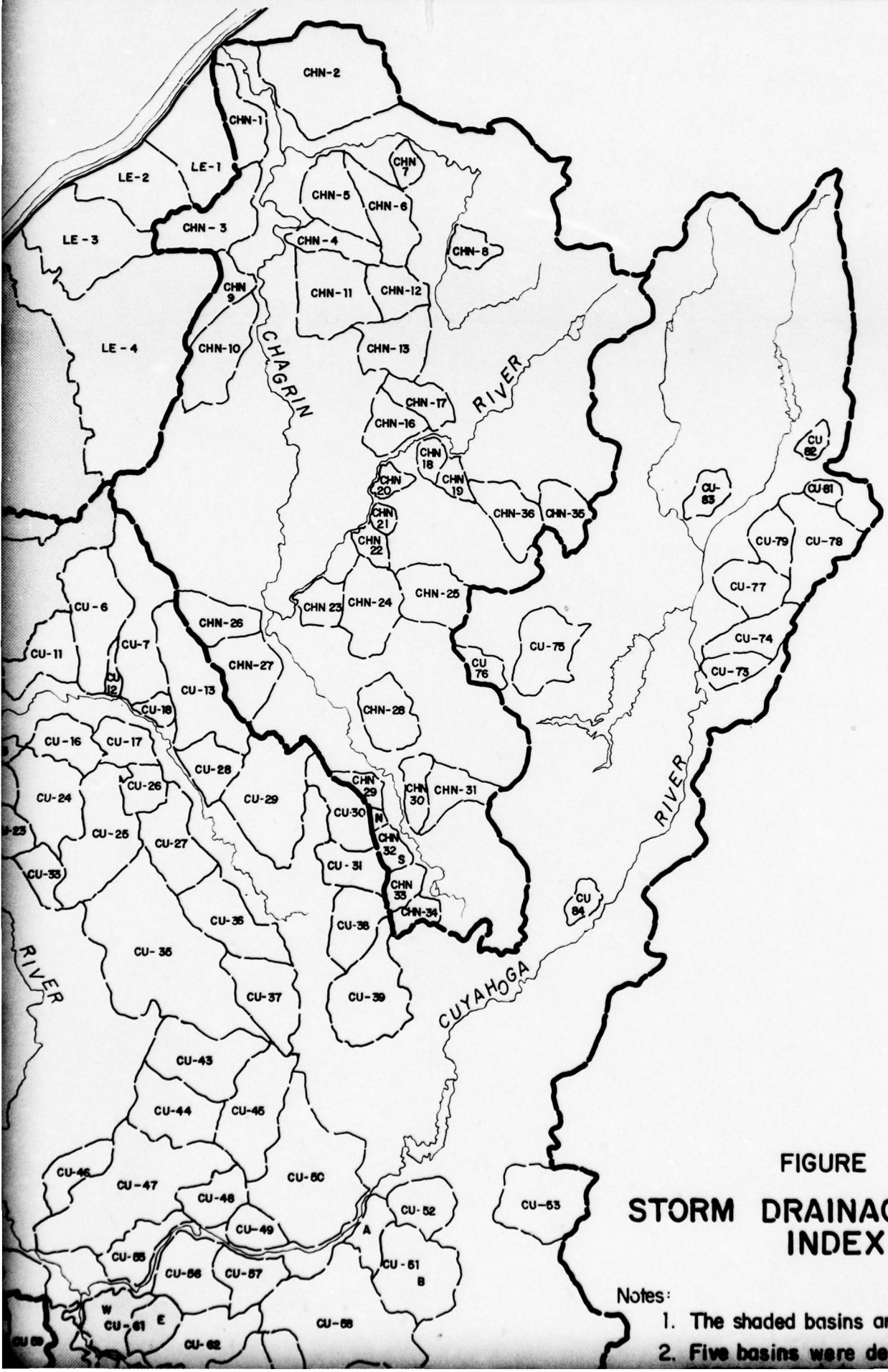
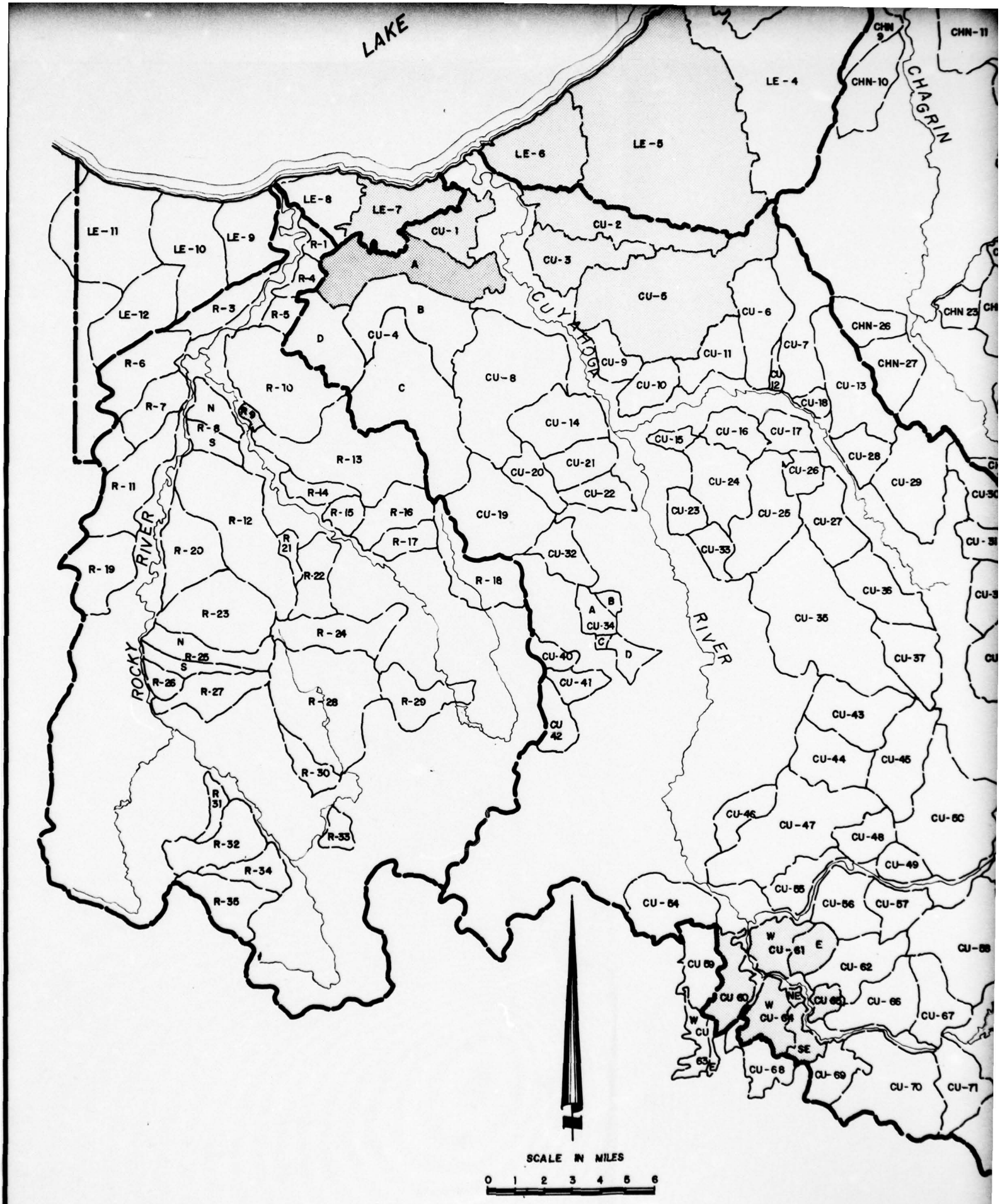


FIGURE IV-7

STORM DRAINAGE DISTRICTS INDEX MAP

Notes:

1. The shaded basins are combined sewer systems
2. Five basins were deleted from the numbering


LAKE
CHN 9
CHN-11
LE-4
CHN-10
CHAGRIN
LE-5
LE-6
LE-8
LE-7
CU-1
CU-2
LE-11
LE-10
LE-9
R-1
A
CU-3
R-4
CU-5
CUYAHOGA
LE-12
R-3
R-5
B
CU-6
CHN 23
CHN-26
D
CU-4
CU-7
R-6
CU-9
CU-11
CHN-27
R-10
C
CU-8
CU-10
CU 12
CU-13
R-7
N
R-9
CU-18
R-8
S
CU-14
CU-15
CU-16
CU-17
CU-28
R-13
CU-20
CU-21
CU-26
R-11
CU-24
CU-29
R-14
CU-22
R-12
R-15
R-16
CU-19
CU-23
CU-25
CU-27
CU-33
R-20
R 21
R-17
CU-32
R-19
ROCKY RIVER
R-22
R-18
CU-36
A
B
CU-34
C
D
CU-35
RIVER
R-23
R-24
N
R-25
S
CU-40
CU-37
R-26
R-27
CU-41
R-28
R-29
CU-43
CU 42
CU-44
CU-45
R-30
R 31
CU-46
CU-47
CU-48
CU-50
R-32
R-33
CU-49
R-34
CU-55
CU-56
CU-57
R-35
CU-64
W
CU-61
E
CU-58
CU 59
CU-62
CU 60
NE
CU 65
CU-66
CU-67
W
CU-64
W
CU
63
E
SE
CU-68
CU-69
CU-70
CU-71
SCALE IN MILES
0 1 2 3 4 5 6

3

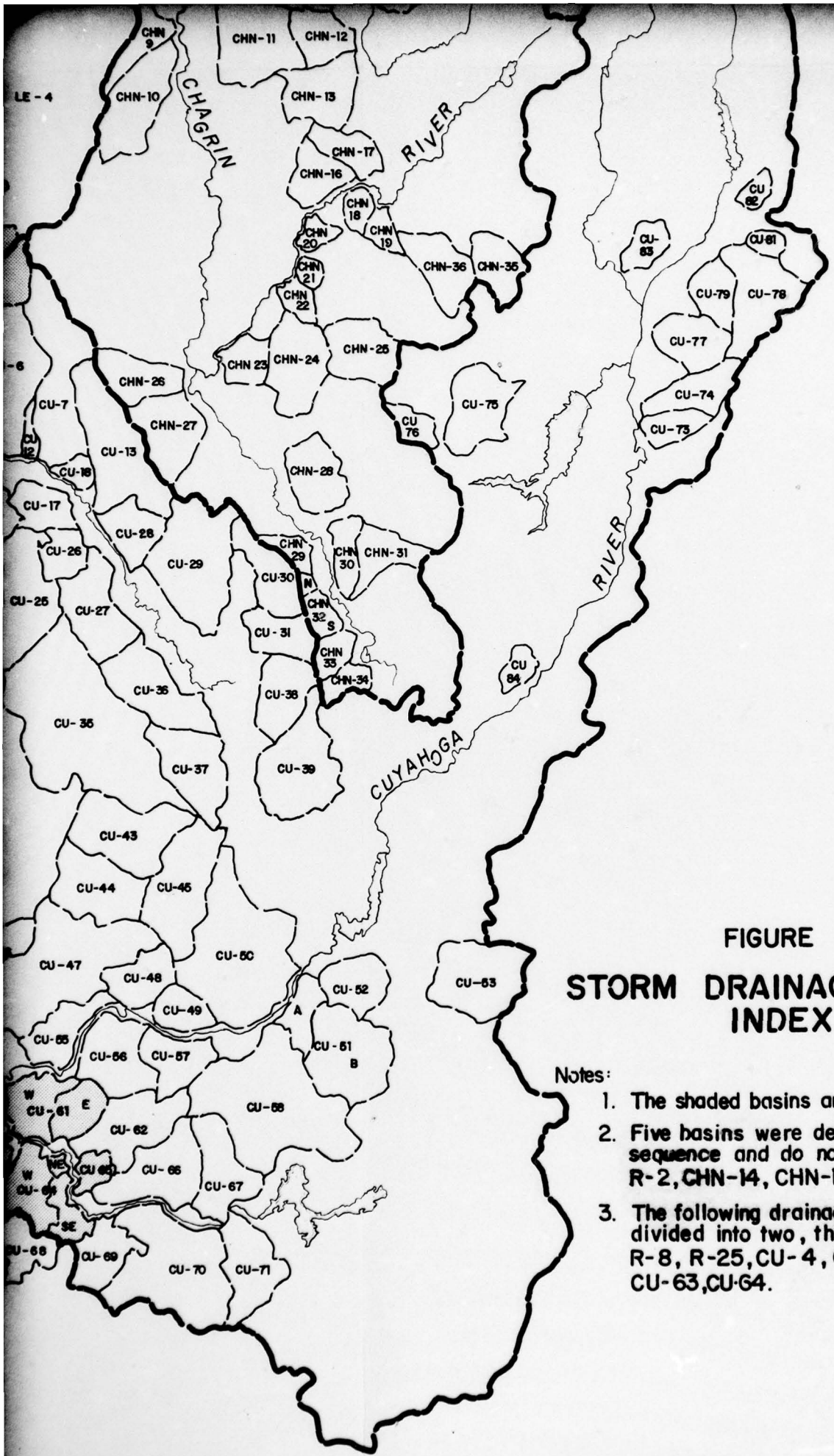


FIGURE IV-7

STORM DRAINAGE DISTRICTS INDEX MAP

Notes:

1. The shaded basins are combined sewer systems
2. Five basins were deleted from the numbering sequence and do not appear on this map : R-2, CHN-14, CHN-15, CU-72, and CU-80.
3. The following drainage basins have been subdivided into two, three or four parts : CHN-32, R-8, R-25, CU-4, CU-34, CU-51, CU-61, CU-63, CU-64.

SECTION V

COSTS

In this section of the report the procedure used for estimating costs is explained, the costs of the three plans are displayed, and particular components of the three plans are compared with respect to cost. The cost estimates were prepared to permit comparisons among the plans, to identify the costs of the various major components of each plan, e.g., sewers, treatment plants, pumps, and reservoirs, and to separate the costs related to treating stormwater from the costs of treating municipal and industrial wastewaters in each plan. The cost figures used for these purposes incorporated both construction costs (Capital Costs) and the costs of operating and maintaining the systems after construction (O & M Costs).

ANNUAL COSTS

The need for cost comparability among plans led to the adoption of a standardized procedure for design work and cost estimation. First, each plan was laid out to meet projected wastewater loads by decades to the year 2020. Second, the cost of the plan was built up by components, phasing new construction and the expansion of existing facilities as the water quality standards and the wastewater load required.* Third, the capital costs for each component of the wastewater treatment system were converted to an annual cost based on three possible interest rates,

*The methodology for computing the costs of individual components of a plan has been explained in detail in the Phase II Formulation Appendix; it is based upon a cost per unit of measurement related to the component in question (i.e. cost per million gallons of storage, etc.).

amortized over the estimated useful life of the particular component. The amortization period begins in the year an expenditure is made, and the amount of the expenditure was calculated on the basis of 1972 prices. Finally, the annual capital cost for each component of the plan was added to the annual operation and maintenance cost. The pattern of annual costs for a plan must be known to develop the financial support program.

The total annual costs by decades are summarized in Table V-5, showing Capital and O & M costs, and in Table V-6, showing Municipal/Industrial and Stormwater costs. Tables V-7 through V-9 give a breakdown of annual costs by components at five year intervals. Thus the total annual costs of the three plans may be compared in these years. Contingency factors were applied separately to the total annual capital costs and to the total O & M costs for each plan.

PRESENT WORTH

Since implementation of any of the three plans would occur over a period of fifty years, with varying construction schedules and capital and O & M costs, a present-worth analysis was made to provide a single cost basis for comparisons of the same components in different plans and of the total present worths for each of the three plans. The present-worth factor, applied to a scheduled future expenditure, is a compound interest factor based upon a given interest rate and the number of years which will elapse between a fixed "present" date (January 1, 1972, in this study) and the date of the expenditure.

Stated simply, a present-worth analysis shows that amount of money at the beginning of the time period (or the present) which, earning a given rate of interest until the date of expenditure, would be sufficient

to equal the expenditure. In this study three given interest rates were used: 5 3/8 percent, 7 percent and 10 percent. The summation of the present worths for both the capital and O & M costs of all components in a plan over the fifty-year period equals the total present worth of the plan. This figure provides an index of the magnitude of expenditure required to implement the plan from the standpoint of present time.

CONTINGENCY FACTORS

The unit costs used by the several contractors engaged in this study were all intended to approximate the actual anticipated costs as closely as possible without an added margin for contingencies. This procedure permitted a standardization of the allowance made for contingencies and enabled it to remain visible by being added to the totals for both annual costs and present worth. The contingency factors used were 30 percent for capital costs, of which 5 percent represented engineering and design and 5 percent represented supervision and administration, and 20 percent for operation and maintenance costs.

Table V-2 shows the contingency allowances at present worth applied to the three basic treatment categories: industrial pretreatment, municipal/industrial, and storm runoff. In this table the contingency amounts include both capital and O & M and therefore fall between 20% and 30% of the base totals. Tables V-5 and V-6 display the contingency allowances on an annual-cost basis.

EXPLANATION OF TABLES

Tables V-1 through V-12 display the estimated costs of the three plans, as the plans were described in Section IV. All costs are in 1972 dollars. The tables are grouped into two sets; the first showing present-worth costs and the second showing annual costs. Both sets begin with condensed summary displays and proceed to more detailed breakdowns, which itemize the costs from two separate aspects. These detailed tables present first an itemization of costs for the various major components of the proposed wastewater management systems and, second, a tabulation of costs for the individual municipal treatment plants.

Table V-1

The total present worths shown in this table for each plan comprise both capital costs and operation and maintenance costs with the respective contingency factors applied and those amounts included for all three categories of wastewater treatment considered in this study: industrial pre-treatment, municipal/industrial wastewater treatment, and urban storm runoff treatment. The cost amounts in Table V-1 were summarized for easy reference directly from the grand totals in Table No. V-2. These are the only two tables which contain the total costs for the plans, including the category of industrial pre-treatment, and they are the only two present-worth tables which include contingency cost allowances.

Table V-2

As in the preceding table, the total present-worth costs for Plans A, B, and C are given at each of the three interest rates used in this study. Contingency amounts are shown separately. The costs actually estimated by the three technical contractors are listed under the heading "Base Total," which includes both capital and operation and maintenance costs. The Industrial Pre-treatment costs were derived from Table XXXIV of AWARE's Phase II Report, which gives present-worth cost data for Industrial Treatment Alternative 3. The data used included both initial and replacement capital costs and operation and maintenance costs for "Treatment," "Sludge Disposal," and "Brine Treatment by Evaporation." The only adjustment made to data from Table XXXIV was to remove the 30 per cent contingency amount from the initial capital cost of $317,400,000 given in that table. The replacement and operation and maintenance costs in Table XXXIV do not include contingencies. Since the same industrial treatment scheme was stipulated for all three plans, the cost differences among plans relate only to the municipal/industrial and storm runoff portions.

Table V-3A.

The "base total" costs for the Municipal/Industrial and Storm Runoff treatment categories in Table V-2 are shown in Table V-3A, separated into capital costs and operation and maintenance costs. The standard contingency allowances are not included in this table. Since a higher contingency factor is applied to capital costs than to operation and maintenance costs, the effect of adding contingencies would be to increase slightly the total cost of a "high-capital" plan, such as Plan C, relative to a "high-O&M" plan, such as Plan A.

Also related to the ratio of capital to operation and maintenance costs for a plan is the effect of calculating present-worth at different interest rates. As can be determined from Table V-3A, the higher interest rate of ten per cent tends to decrease the present-worth of operation and maintenance costs relative to capital costs. Thus, Plan A compares more favorably with Plan C at higher interest rates.

Table V-3.

This table itemizes the present-worth costs for the major cost items or "components" in Plans A, B, and C. For example, at an interest rate of 5 and 3/8 per cent for Plan A, the cumulative present-worth of all capital costs for expanding municipal/industrial treatment plants specifically to meet Level 1 criteria is calculated as $81,896 thousand, which appears in the upper left-hand column of data in Table V-3. The purpose of this cost display is to enable a comparison of the costs for different components within a plan and a comparison of the costs for the same components between plans. Such an analysis is of particular interest when the total costs for different plans are closely similar but the distribution of costs among the components is widely variant.

The components listed for the present-worth summary in Table V-3 and for the annual cost summaries in Tables V-7, 8, and 9 are largely self-explanatory. Costs for components related to water-based treatment, including treatment plants, plant expansions to meet Level 1 and Level 2 criteria, sludge facilities, sewers, and stormwater detention basins, were estimated by Havens and Emerson, Ltd. The remaining costs relate to land-based treatment components and were estimated by Wright-McLaughlin Engineers.

A brief explanation of each of the components follows:

1. Plants. Under Municipal/Industrial, this item includes capital costs for replacement and expansion of existing secondary-level treatment facilities, new plant construction, even when built to meet Level 1 criteria, and

construction of "preliminary" treatment facilities in conjunction with aerated lagoons or tunnel inlets. All operation and maintenance costs for water-based treatment plants, regardless of level, are included in this item, rather than being distributed among the first three items. Under Storm Runoff, this component includes advanced storm-water treatment plants and preliminary treatment facilities prior to separate land treatment. Costed by Havens & Emerson, Ltd. (H & E).

2. & 3. Expand to Level 1 and Expand to Level 2. These two items include only capital costs for municipal/industrial treatment plant components specifically classified as Level 1 or Level 2, (H & E) and do not reflect the higher operation and maintenance costs incurred by the expansion of the plant.

4. Sludge Facilities. This item includes capital and operation and maintenance costs for both municipal/industrial and storm runoff sludge-handling facilities. (H & E) Where a sludge disposal scheme involves land treatment on either agricultural or strip-mined land, the storage, transportation, and application steps were costed by Wright-McLaughlin Engineers (WME) in Item Number 17.

5. Sewers. This item includes both the muncipal/industrial and storm sewer systems costs for capital and operation and maintenance. (H & E)

6. Detention Basins. This item relates only to capital costs for storm runoff. (H & E)

7. Temporary Pumps. This is a special storm runoff item, which includes capital and operation and maintenace costs, and pertains only to an interim mode of treatment for combined sewer overflows in Plan C between 1980 and 1985. (WME)

8. Shafts and Tunnels. This item pertains only to the Transmission Tunnel in Plan C and includes capital and operation and maintenance costs allotted to both municipal/industrial and storm runoff in proportion to the average daily flow contributed to the tunnel from each source. The costs include mined storage space for flow-levelling and tunnel aeration equipment. (WME)

9. Aerated Lagoons. This item appears in Plans B and C where aerated lagoons were assumed for estimating costs of secondary treatment prior to land treatment in municipal systems. Both the aerobic and facultative lagoons are included in this item. Costs were pro-rated for storm runoff treated in municipal facilities. Site acquisition costs were included in this item. (WME)

10. Secondary Pumping. This item refers to capital and operation and maintenance costs for pumping municipal/industrial secondary effluent from aerated lagoons to winter storage reservoirs within the Study Area and for the lift from the lower end of the tunnel to the aerated lagoon at the Western Land Treatment Area. Pumping costs from detention basins to winter storage reservoirs were included for storm runoff. (WME)

11. Force Mains. This item pertains to all force mains associated with the pumping stations in the preceding item, including the lift shaft from the tunnel and force mains to winter storage reservoirs within the Study Area. (WME)

12. Storage Reservoirs. This item refers to winter storage reservoirs for municipal/industrial secondary effluent and for preliminarily-treated storm runoff prior to land treatment. Land costs for site acquisition were included in this item. (WME)

13. Reservoir Aeration and Chlorination. This item includes aeration and chlorination for municipal/industrial winter storage reservoirs for in-basin treatment and chlorination only for separate storm-runoff winter storage reservoirs and for the Western Land Treatment Area reservoir. (WME)

14. Land Purchase and Preparation. This capital cost item includes two categories of land. The costs of site acquisition for water-based plants are treated as occurring in 1972 and are the only capital costs appearing in that year. (H & E) The costs for purchase of land treatment areas and the necessary "one-time" re-location, clearing, and land-forming costs occur later. (WME) All costs on this line are amortized over an assumed fifty-year life, but the total undepreciated expenditures are retained as the 2020 residual amounts for purposes of calculating present-worth costs.

15. Irrigation Systems. This item comprises the distribution and irrigation systems from the winter storage reservoirs to the irrigated fields, including force mains and pumping facilities. (WME)

16. Drainage Systems. This item includes all portions of the drainage systems for the land treatment sites and the conduits and canals required to convey the tile effluent to natural drainage channels with adequate capacity. (WME)

17. Sludge Management. This item includes costs for storage, transportation, and land application of sludge to receive land treatment. All costs for the pipeline to the strip-mined area are included in this item, as are costs of agricultural lands. (WME)

18. Miscellaneous. This item is not a contingency allowance, but rather an estimation of the costs for a category of appurtenances and ancillary features, which would be characteristic of the transition to a geographically dispersed land treatment system. Miscellaneous capital costs were calculated as follows: ten per cent of the capital expenditures for aerated lagoons, representing costs for fencing and for pipeline connections to existing treatment plants and to temporary stream return-flow structures from the aerated lagoons within the Study Area during the period 1977 to 1983; PLUS nine per cent of the capital expenditures for land purchase and preparation, which is equivalent to the purchase of an additional twenty per cent of the net acreage needed for land treatment; PLUS five per cent of the capital expenditures for both irrigation and drainage systems, representing costs for monitoring stations and some re-channeling of small creeks and streams. Miscellaneous operation and maintenance costs were calculated as five per cent of all foregoing miscellaneous capital expenditures. (WME)

Table V-4.

The total present-worth costs for the municipal/industrial treatment category in Tables V-2, -3A, and -3 are broken down in Table V-4 to the costs for individual treatment plants. The plants listed correspond to those in Tables IV-1, -2, and -3 with the addition of "Interim Plants" and the "Strip-Mine Pipeline". Interim plants include those existing facilities which are phased out during the study period, expecially along the East Branch of the Rocky River, Tinkers Creek, and in the central Cuyahoga Valley. Both capital costs and operation and

maintenance costs were estimated for the interim plants up to their proposed phase-out dates. The strip-mine pipeline, which would serve a number of treatment plants in Plans A and B and would transport the great majority of the sludge generated in the Study Area after 1990, is listed as though it were a separate municipal/industrial treatment plant. A number of the treatment plants listed appear in only one or two of the three plans.

Table V-5.

This table presents a summary of the total annual costs by decade for Plans A, B and C exclusive of the costs for industrial pre-treatment. The annual capital costs were computed based on capital recovery factors for an interest rate of 7%. The annual operation and maintenance costs for the facilities scheduled to be operating in a given year were calculated in 1972 dollars independently of the interest rate. The base amounts in this table were summarized from Tables V-7, 8 and 9 at the bottoms of pages V-20, V-23 V-26 , respectively. Table V-5 shows the standard contingency allowances as they apply to annual costs.

Table V-6.

The total annual capital and O&M costs from the preceding table are shown in Table V-6 separated into the Municipal/Industrial and Storm Runoff Treatment categories. The total contingency costs shown for each decade apply to all the annual costs given in the table. The base amounts (without contingencies) were summarized from the Total Annual Costs displayed at the bottoms of pages, V-18, 19, 21, 22, 24 and 25.

Tables V-7, V-8 and V-9.

These three tables contain detailed annual cost data for Plans A, B and C, respectively. Each table covers three pages, the first for municipal/industrial wastewater treatment, the second for storm runoff treatment, and the third representing the summation of the first and second. The costs are itemized for the "components" described in Table V-3 above. On each page of these three tables, cost data are displayed at five-year intervals for capital expenditures, annual capital costs, annual operation and maintenance costs and total annual costs. This format is a summarization of the more detailed framework within which the costs were actually estimated and then processed by computer. Initially, the costs for land treatment components associated with each municipal treatment plant and with each storm runoff drainage district were assigned by year through 1990, rather than at 5-year intervals. These yearly costs were the basis for the calculation of present worth and for the distribution of annual capital and O&M costs. In the first block of data on each page of Tables V-7, 8 and 9, the capital "expenditures", i.e., the capital costs shown in the year of construction or acquisition, are summarized for each five-year period in the first year of the period. Thus, in these summary tables, a capital expenditure assigned to 1983 would be shown in 1980, whereas the annual capital cost of the item would first appear in 1985. Such discrepancies did not affect the computations of total costs or present worth.

Similarly, the costs prepared by Havens and Emerson, Ltd. are sometimes given in these tables in different years than those shown in H&E's Phase III Report, where costs were summarized by 10-year intervals after 1990. Actually, H&E calculated the costs based on the more detailed framework of 5-year intervals.

The number of years shown for each item under "Item Life" in these tables was used to schedule replacement of capital facilities and to compute the annual capital costs. The residual amounts shown beside the capital expenditures represent that fraction of each expenditure proportional to its remaining life in the year 2020, with the exception of "Land Purchase and Preparation", which is considered to be undepreciated. All expenditures shown in 2020 are treated as being 100% residual.

The annual capital costs are displayed by item for only one of the three interest rates, but the totals are given for all three rates. Both the annual capital and the annual O&M costs were summed by computer from the detailed arrays for the individual treatment plants in each plan. The total annual costs at the three interest rates are shown at the bottom of each page in these tables.

Tables V-10, V-11 and V-12.

These tables present the annual costs for municipal/industrial wastewater only, itemized by treatment plant as described in Table V-4 above. The display of cost data under capital expenditures, annual capital costs, annual O&M costs and total annual costs is the same as in Tables V-7, 8 and 9. The total annual costs at the bottom of the third pages of Tables 10, 11 and 12 correspond to those at the bottom of the first pages of Tables 7, 8 and 9, respectively. The differences between these corresponding sets of data are below the level of significance and are due to truncations in the course of data processing.

TABLE V-1

TOTAL PRESENT WORTH OF PLANS A, B, C*

(in $1000)

Present Worth Factor	Plan A	Plan B	Plan C
5 3/8 Percent	4,227,100	4,085,500	3,881,000
7 Percent	3,470,500	3,360,600	3,227,500
10 Percent	2,608,300	2,534,300	2,455,100

*Contingency factors included.

TABLE V-2

TOTAL PRESENT WORTH OF PLANS A, B, AND C
FOR INDUSTRIAL PRETREATMENT, MUNICIPAL/INDUSTRIAL AND STORM RUNOFF COSTS
(In $1000)

5 3/8%

Treatment Category	PLAN A			PLAN B			PLAN C		
	Base Total	Contingency	Grand Total	Base Total	Contingency	Grand Total	Base Total	Contingency	Grand Total
Industrial Pretreatment	1,008,900	233,800	1,242,700	1,008,900	233,800	1,242,700	1,008,900	233,800	1,242,700
Municipal/Industrial	1,397,900	335,400	1,733,300	1,326,900	318,200	1,645,100	1,380,800	347,600	1,728,400
Storm Runoff	977,000	274,100	1,251,100	935,300	262,400	1,197,700	709,700	200,200	909,900
Total	3,383,800	843,300	4,227,100	3,271,100	814,400	4,085,500	3,099,400	781,600	3,881,000

7%

Treatment Category	PLAN A			PLAN B			PLAN C		
	Base Total	Contingency	Grand Total	Base Total	Contingency	Grand Total	Base Total	Contingency	Grand Total
Industrial Pretreatment	820,700	193,100	1,013,800	820,700	193,100	1,013,800	820,700	193,100	1,013,800
Municipal/Industrial	1,122,700	272,300	1,395,000	1,067,400	258,600	1,326,000	1,154,200	293,400	1,447,600
Storm Runoff	826,900	234,800	1,061,700	795,100	225,700	1,020,800	596,000	170,100	766,100
Total	2,770,300	700,200	3,470,500	2,683,200	677,400	3,360,600	2,570,900	656,600	3,227,500

10%

Treatment Category	PLAN A			PLAN B			PLAN C		
	Base Total	Contingency	Grand Total	Base Total	Contingency	Grand Total	Base Total	Contingency	Grand Total
Industrial Pretreatment	630,400	152,800	783,200	630,400	152,800	783,200	630,400	152,800	783,200
Municipal/Industrial	807,400	198,800	1,006,200	769,200	189,000	958,200	868,800	223,400	1,092,200
Storm Runoff	635,600	183,300	818,900	615,500	177,400	792,900	449,500	130,200	579,700
Total	2,073,400	534,900	2,608,300	2,015,100	519,200	2,534,300	1,948,700	506,400	2,455,100

TABLE V-3A

*PRESENT WORTH SUMMARY OF PLANS A, B, AND C**

FOR MUNICIPAL/INDUSTRIAL AND STORM RUNOFF ONLY

(In $1000)

5 3/8%

	PLAN A			PLAN B			PLAN C		
	Municipal/ Industrial	Stormwater	Total	Municipal/ Industrial	Stormwater	Total	Municipal/ Industrial	Stormwater	Total
CAPITAL	558,500	786,900	1,345,400	528,700	752,300	1,281,000	714,400	582,500	1,296,900
O & M	839,400	190,100	1,029,500	798,200	183,000	981,200	666,400	127,200	793,600
TOTAL	1,397,900	977,000	2,374,900	1,326,900	935,300	2,262,200	1,380,800	709,700	2,090,500

7%

	PLAN A			PLAN B			PLAN C		
	Municipal/ Industrial	Stormwater	Total	Municipal/ Industrial	Stormwater	Total	Municipal/ Industrial	Stormwater	Total
CAPITAL	477,400	694,100	1,171,500	451,300	666,800	1,118,100	626,100	508,700	1,134,800
O & M	645,300	132,800	778,100	616,100	128,300	744,400	528,100	87,300	615,400
TOTAL	1,122,700	826,900	1,949,600	1,067,400	795,100	1,862,500	1,154,200	596,000	1,750,200

10%

	PLAN A			PLAN B			PLAN C		
	Municipal/ Industrial	Stormwater	Total	Municipal/ Industrial	Stormwater	Total	Municipal/ Industrial	Stormwater	Total
CAPITAL	373,000	561,500	934,500	351,600	543,400	895,000	496,900	402,600	899,500
O & M	434,400	74,100	508,500	417,600	72,100	489,700	371,900	46,900	418,800
TOTAL	807,400	635,600	1,443,000	769,200	615,500	1,384,700	868,800	449,500	1,318,300

*Contingencies not included

TABLE V-3

PRESENT WORTH OF PLANS A, B, AND C*

PRESENT WORTH AT 5 3/8 %

(IN $1000)

ITEM	PLAN A			PLAN B			PLAN C		
	MUNICIPAL/ INDUSTRIAL	STORM RUNOFF	TOTAL	MUNICIPAL/ INDUSTRIAL	STORM RUNOFF	TOTAL	MUNICIPAL/ INDUSTRIAL	STORM RUNOFF	TOTAL
PLANTS	948960	451039	1399999	860279	392846	1253126	493623	193201	686826
EXPAND TO LEVEL 1	81695	0	81696	81575	0	81575	71776	1005	72781
EXPAND TO LEVEL 2	102592	0	102592	93637	0	93637	13076	1717	14794
SLUDGE FACILITIES	122937	30369	153306	111388	29132	140522	93693	13036	106730
SEWERS	77156	188598	265756	71996	188980	260977	76955	179157	256114
DETENTION BASINS	0	299609	299609	0	295394	295394	0	158432	158432
TEMPORARY PUMPS	0	0	0	0	0	0	0	1918	1918
SHAFTS & TUNNELS	0	0	0	0	0	0	223993	59632	283626
AERATED LAGOONS	0	0	0	19782	1286	21069	90443	15323	105766
SECONDARY PUMPING	0	0	0	5903	6141	12045	80819	21049	101870
FORCE MAINS	0	0	0	2768	2384	5154	4642	2404	7047
STORAGE RESERVOIRS	0	0	0	11387	5625	17014	39477	10436	49914
RESERVOIR AER & CL	0	0	0	7385	1716	9102	21719	9748	31467
LAND PURCHASE & PREP	4149	7376	11525	6623	8100	14724	32010	13555	45566
IRRIGATION SYSTEMS	0	0	0	4547	2286	6834	54145	12007	66152
DRAINAGE SYSTEMS	0	0	0	2473	886	3360	31017	6549	37567
SLUDGE MANAGEMENT	60331	0	60331	45534	0	45534	43528	7240	50769
MISCELLANEOUS	0	0	0	1638	441	2080	9845	3326	13172
TOTAL	1397930	976992	2374923	1326931	935227	2262159	1380765	709748	2090515

PRESENT WORTH AT 7 %

(IN $1000)

ITEM	PLAN A			PLAN B			PLAN C		
	MUNICIPAL/ INDUSTRIAL	STORM RUNOFF	TOTAL	MUNICIPAL/ INDUSTRIAL	STORM RUNOFF	TOTAL	MUNICIPAL/ INDUSTRIAL	STORM RUNOFF	TOTAL
PLANTS	735753	352168	1087923	667271	308852	976124	419657	152295	571952
EXPAND TO LEVEL 1	74968	0	74968	74680	0	74680	68234	825	69060
EXPAND TO LEVEL 2	82165	0	82165	75153	0	75153	10287	1395	11682
SLUDGE FACILITIES	106087	23705	129793	96556	22788	119345	84092	9424	93516
SEWERS	69485	166803	236289	64921	167128	232050	69293	157665	226959
DETENTION BASINS	0	276840	276840	0	272899	272899	0	144340	144340
TEMPORARY PUMPS	0	0	0	0	0	0	0	1724	1724
SHAFTS & TUNNELS	0	0	0	0	0	0	189442	50870	240314
AERATED LAGOONS	0	0	0	15903	873	16777	65006	10587	75595
SECONDARY PUMPING	0	0	0	4390	4390	8780	56699	14785	71485
FORCE MAINS	0	0	0	2400	1954	4355	4006	1971	5978
STORAGE RESERVOIRS	0	0	0	9415	4430	13845	32300	8356	40658
RESERVOIR AER & CL	0	0	0	5380	1182	6564	15466	6841	22309
LAND PURCHASE & PREP	4149	7376	11525	6355	7966	14322	28613	12861	41474
IRRIGATION SYSTEMS	0	0	0	3471	1656	5129	41183	9058	50242
DRAINAGE SYSTEMS	0	0	0	2008	689	2698	25116	5284	30401
SLUDGE MANAGEMENT	50016	0	50016	38118	0	38118	36616	5257	41874
MISCELLANEOUS	0	0	0	1377	317	1694	8033	2436	10469
TOTAL	1122658	826894	1949552	1067411	795135	1862547	1154257	595987	1750246

PRESENT WORTH AT 10 %

(IN $1000)

ITEM	PLAN A			PLAN B			PLAN C		
	MUNICIPAL/ INDUSTRIAL	STORM RUNOFF	TOTAL	MUNICIPAL/ INDUSTRIAL	STORM RUNOFF	TOTAL	MUNICIPAL/ INDUSTRIAL	STORM RUNOFF	TOTAL
PLANTS	501478	236572	738050	454884	210359	665244	327117	103269	430407
EXPAND TO LEVEL 1	65918	0	65918	65673	0	65673	62531	593	63125
EXPAND TO LEVEL 2	55896	0	55896	51214	0	51214	6842	998	7840
SLUDGE FACILITIES	84569	16368	100938	77437	15792	93229	70718	5709	76429
SEWERS	58219	135715	193934	54515	135996	190511	57996	127126	185122
DETENTION BASINS	0	239547	239547	0	236162	236162	0	122152	122152
TEMPORARY PUMPS	0	0	0	0	0	0	0	1419	1419
SHAFTS & TUNNELS	0	0	0	0	0	0	139741	38107	177849
AERATED LAGOONS	0	0	0	11496	444	11941	38102	5609	43711
SECONDARY PUMPING	0	0	0	2738	2520	5260	31530	8227	39759
FORCE MAINS	0	0	0	1864	1375	3239	3074	1387	4462
STORAGE RESERVOIRS	0	0	0	6841	2901	9743	22691	5621	28324
RESERVOIR AER & CL	0	0	0	3249	642	3892	8890	3813	12704
LAND PURCHASE & PREP	4149	7376	11525	5647	7737	13385	22128	11534	33663
IRRIGATION SYSTEMS	0	0	0	2262	979	3241	26213	5686	31899
DRAINAGE SYSTEMS	0	0	0	1429	448	1878	17352	3623	20976
SLUDGE MANAGEMENT	37200	0	37200	28646	0	28646	28215	3100	31315
MISCELLANEOUS	0	0	0	1068	184	1252	5640	1454	7099
TOTAL	807433	635580	1443014	769175	615549	1384724	868734	449465	1318249

*for Municipal/Industrial Wastewater and Storm Runoff only.

TABLE V-4

PRESENT WORTH OF MUNICIPAL FACILITIES IN PLANS A, B, AND C
(in $1000)

	5 3/8%			7%			10%		
	PLAN A	PLAN B	PLAN C	PLAN A	PLAN B	PLAN C	PLAN A	PLAN B	PLAN C
RANDOLPH	3249	1591	1591	2609	1332	1332	1884	1015	1015
NEW KENT	35077	35077	32573	28328	28328	27046	20838	20838	20307
BURTON	3709	6408	6408	2956	5545	5545	2097	4466	4466
MANTUA	3469	1441	1441	2767	1195	1195	1974	895	895
BUTTERNUT CREEK	4590	2463	2463	3730	2088	2088	2736	1617	1617
CHARDON	274	472	472	241	380	380	192	270	270
EAST CLARIDON	1519	916	916	1208	764	764	859	578	578
TROY TOWNSHIP	1433	875	875	1127	713	713	785	519	519
AUBURN TOWNSHIP	3295	1681	1681	2623	1373	1373	1858	1001	1001
SHALERSBORO	0	3018	3018	0	2439	2439	0	1743	1743
RAVENNA	19991	12770	12770	15864	10467	10467	11251	7699	7699
AURORA CENTRAL	8505	3807	3807	6771	3111	3111	4782	2253	2253
FAIRMOUNT ROAD	8916	4468	4468	7092	3663	3663	5037	2684	2684
FOWLER'S MILL	6788	3441	3441	5545	2917	2917	4117	2277	2277
NEWBURY TOWNSHIP	4629	2195	2195	3648	1779	1779	2539	1282	1282
CHAGRIN FALLS	11177	10499	10499	9020	8963	8963	6560	7071	7071
CHAGRIN EAST BRANCH	7507	3579	3579	6154	3056	3056	4583	2400	2400
UPPER EAST BRANCH	0	1549	1549	0	1240	1240	0	878	878
HINCKLEY	0	4645	4645	0	4095	4095	0	3385	3385
MEDINA COUNTY	0	5294	5043	0	4413	4176	0	3359	3146
NEW MEDINA	0	11186	11186	0	9519	9519	0	7494	7494
MALLET CREEK	0	1182	1182	0	980	980	0	737	737
LIVERPOOL	45842	6146	6146	38221	5230	5230	29280	4125	4125
WESTERN LAND TREATMENT	0	0	505638	0	0	402501	0	0	269975
MIDDLEFIELD	8359	0	0	6737	0	0	4888	0	0
MC FARLAND CREEK	13045	0	0	10799	0	0	8214	0	0
STRIP-MINE PIPELINE	13237	13237	0	10232	10232	0	6566	6566	0
INTERIM PLANTS	41065	39752	30032	36818	35575	26922	30753	29623	22538
AKRON	203528	203528	208125	161575	161575	164499	113558	113558	114964
EUCLID	55388	55388	24885	43744	43744	22578	30629	30629	19220
LAKEWOOD	47650	47650	25947	38688	38688	23652	28355	28355	20264
NORTH OLMSTED	0	0	26250	0	0	23220	0	0	18823
ROCKY RIVER	29586	29586	12406	22687	22687	10960	14995	14995	8894
WILLOUGHBY-EASTLAKE	31655	31655	14034	24221	24221	12363	15976	15976	9962
EASTERLY	281368	281368	137586	221569	221569	121852	154187	154187	100064
SOUTHERLY	402860	399699	202692	323350	321122	181858	232288	231030	152456
WESTERLY	100191	100336	67192	84303	84372	61746	65621	65639	53749
TOTAL	1397902	1326902	1380735	1122627	1067375	1154222	807402	769144	868751

TABLE V-5

TOTAL ANNUAL CAPITAL AND O & M COSTS OF PLANS A, B, AND C
FOR MUNICIPAL/INDUSTRIAL WASTEWATER AND STORM RUNOFF
(in $1000)

	1972	1980	1990	2000	2010	2020
Plan A						
Annual Capital*	800	78,800	151,300	180,600	180,100	180,100
Contingency (30%)	200	23,600	45,400	54,200	54,000	54,000
Annual O & M	31,000	47,400	76,500	85,000	94,500	102,700
Contingency (20%)	6,200	9,500	15,300	17,000	18,900	20,500
Total	38,200	159,300	288,500	336,800	347,500	357,300
Plan B						
Annual Capital*	800	75,800	141,700	170,000	170,100	170,400
Contingency (30%)	200	22,700	42,500	51,000	51,000	51,100
Annual O & M	31,300	45,500	73,000	79,900	87,600	93,800
Contingency (20%)	6,300	9,100	14,600	16,000	17,500	18,800
Total	38,600	153,100	271,800	316,900	326,200	334,100
Plan C						
Annual Capital*	700	57,900	157,800	169,000	159,900	157,100
Contingency (30%)	200	17,400	47,300	50,700	48,000	47,100
Annual O & M	30,800	41,100	61,200	54,600	59,300	62,200
Contingency (20%)	6,200	8,200	12,200	10,900	11,900	12,400
Total	37,900	124,600	278,500	285,200	279,100	278,800

* Annual Capital Costs are based on a 7% interest rate.

TABLE V-6

ANNUAL CAPITAL AND OPERATION AND MAINTENANCE COSTS

FOR PLANS A, B, AND C

SHOWN SEPARATELY FOR MUNICIPAL/INDUSTRIAL WASTEWATER AND STORM RUNOFF
(in $1000)

	1972	1980	1990	2000	2010	2020
Plan A						
Municipal/Industrial						
Capital*	300	25,600	60,200	80,100	79,700	79,700
O&M	31,000	40,300	58,300	63,000	70,300	77,000
Storm Runoff						
Capital*	500	53,200	91,100	100,500	100,400	100,400
O&M	0	7,100	18,200	22,000	24,200	25,700
Contingencies	6,400	33,100	60,700	71,200	72,900	74,500
Total	38,200	159,300	288,500	336,800	347,500	357,300
Plan B						
Municipal/Industrial						
Capital*	300	23,700	55,600	76,600	76,500	76,800
O&M	30,900	38,400	55,300	59,000	65,000	70,100
Storm Runoff						
Capital*	500	52,100	86,100	93,400	93,600	93,600
O&M	400	7,100	17,700	20,900	22,600	23,700
Contingencies	6,500	31,800	57,100	67,000	68,500	69,900
Total	38,600	153,100	271,800	316,900	326,200	334,100
Plan C						
Municipal/Industrial						
Capital*	200	28,200	87,300	90,600	81,400	80,800
O&M	30,800	37,600	47,300	38,400	42,200	44,500
Storm Runoff						
Capital*	500	29,700	70,500	78,400	78,500	76,300
O&M	0	3,500	13,900	16,200	17,100	17,700
Contingencies	6,400	25,600	59,500	61,600	59,900	59,500
Total	37,900	124,600	278,500	285,200	279,100	278,800

*Annual Capital Costs are based on a 7 per cent interest rate

TABLE V-7

PLAN A

ANNUAL COSTS OF MUNICIPAL/INDUSTRIAL WASTEWATER TREATMENT

CAPITAL EXPENDITURES IN $1000

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL	RESIDUAL
PLANTS	35	0	34755	4200	48500	77207	0	258798	50	73513	9830	48500	615353	227555
EXPAND TO LEVEL 1	35	0	82730	2450	0	0	0	19700	2450	83030	0	0	177300	48897
EXPAND TO LEVEL 2	25	0	0	0	185664	0	0	0	0	97669	0	84000	371333	146472
SLUDGE FACILITIES	35	0	51325	960	11500	55795	0	0	0	51325	960	11500	183365	36751
SEWERS	50	0	46198	32473	3934	25499	0	720	0	0	0	0	108724	22479
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	4149	0	0	0	0	0	0	0	0	0	0	4149	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	39	5026	7294	4130	21785	11100	0	6745	0	8575	0	10436	75091	31136
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		9175	282272	44213	271288	169601	0	285963	2500	294082	10790	158436	1528320	534690

ANNUAL CAPITAL COSTS IN $1000 (AT 7%)

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	7361	7685	11419	17415	17415	36785	36785	35707	35707	35707
EXPAND TO LEVEL 1	35	0	6545	6755	6755	6755	6755	6755	6755	6755	6755	6755
EXPAND TO LEVEL 2	25	0	0	0	15175	15175	15175	15175	15175	15175	15175	15175
SLUDGE FACILITIES	35	0	3952	4025	4910	9206	9206	9206	9205	9206	9206	9206
SEWERS	50	0	3326	5663	5939	7776	7776	7827	7827	7827	7827	7827
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	298	298	298	298	298	298	298	298	298	298	298
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	39	0	816	1260	1258	3601	3601	4093	4093	4719	4719	4665
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0
TOTAL AT 5 3/8%		240	18491	21197	38165	50107	50107	66646	66646	66256	66256	66212
TOTAL AT 7 %		298	22300	25630	45759	60231	60231	80145	80145	79693	79693	79638
TOTAL AT 10 %		419	30169	34787	61389	81073	81073	107989	107989	107399	107399	107323

ANNUAL OPERATION AND MAINTENANCE COSTS IN $1000

ITEM	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL
PLANTS	27543	31069	33491	43707	55173	55987	59447	62905	66377	69524	72686	2588254
SLUDGE	3419	3784	4140	2833	1259	1353	1449	1543	1649	1736	1837	105404
SEWERS	0	222	380	400	528	530	532	532	532	532	532	21480
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	0	1993	2265	2584	1364	1438	1520	1607	1703	1821	1949	97660
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	30962	37068	40276	49524	58324	59305	62948	66587	70261	73613	77004	2782798

TOTAL ANNUAL COSTS IN $1000

FOR INTEREST RATE OF 5 3/8 %

TOTAL ANNUAL CAPITAL	240	18491	21197	38165	50107	50107	66646	66646	66256	66256	66212
TOTAL ANNUAL O&M	30962	37068	40276	49524	58324	59305	62948	66587	70261	73613	77004
TOTAL ANNUAL COSTS	31202	55559	61473	87689	108431	109412	129594	133233	136517	139869	143216

FOR INTEREST RATE OF 7 %

TOTAL ANNUAL CAPITAL	298	22300	25630	45759	60231	60231	80145	80145	79693	79693	79638
TOTAL ANNUAL O&M	30962	37068	40276	49524	58324	59305	62948	66587	70261	73613	77004
TOTAL ANNUAL COSTS	31260	59368	65906	95283	118555	119536	143093	146732	149954	153306	156642

FOR INTEREST RATE OF 10 %

TOTAL ANNUAL CAPITAL	419	30169	34787	61389	81073	81073	107989	107989	107399	107399	107323
TOTAL ANNUAL O&M	30962	37068	40276	49524	58324	59305	62948	66587	70261	73613	77004
TOTAL ANNUAL COSTS	31381	67237	75063	110913	139397	140378	170937	174576	177660	181012	184327

TABLE V-7 (Continued)

PLAN A

ANNUAL COSTS OF STORMWATER TREATMENT

CAPITAL EXPENDITURES IN $1000

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL	RESIDUAL
PLANTS	35	0	59300	77370	158750	232130	0	70120	0	59300	77373	158750	693093	329912
EXPAND TC LEVEL 1	35	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	5694	11819	1319	713	0	253	0	5694	11819	1362	38673	15765
SEWERS	50	0	88517	92629	33054	42414	0	48413	0	0	0	0	305027	83247
DETENTION BASINS	50	0	183170	201770	22797	8052	0	6172	0	0	0	0	421951	72367
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	7376	0	0	0	0	0	0	0	0	0	0	7376	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		7376	336681	383588	215910	283309	0	124958	0	64994	89192	160112	1966120	501271

ANNUAL CAPITAL COSTS IN $1000 (AT 7%)

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	4566	10523	22747	40621	40621	46020	46020	46020	46020	46020
EXPAND TC LEVEL 1	35	0	0	0	0	0	0	0	0	0	0	0
EXPAND TC LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	438	1346	1450	1504	1504	1524	1524	1524	1524	1527
SEWERS	50	0	6373	13042	15422	18476	18476	21961	21961	21961	21961	21961
DETENTION BASINS	50	0	13188	27715	29356	29936	29936	30380	30380	30380	30380	30380
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	531	531	531	531	531	531	531	531	531	531	531
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0
TOTAL AT 5 3/8%		427	20345	43128	59611	74440	74440	82110	82110	82110	82110	82113
TOTAL AT 7 %		531	25097	53161	69507	91069	91069	100418	100418	100418	100418	100422
TOTAL AT 10 %		744	34944	73954	96241	125554	125554	136386	138386	138386	136386	138391

ANNUAL OPERATION AND MAINTENANCE COSTS IN $1000

ITEM	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL
PLANTS	0	2093	5515	10911	15531	17054	18634	19551	20514	21116	21759	584405
SLUDGE	0	52	708	1116	1440	1687	1984	2105	2252	2379	2509	70985
SEWERS	0	434	831	1033	1225	1324	1441	1441	1441	1441	1441	53845
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	2579	7104	13060	18196	20065	22059	23097	24237	24936	25709	839235

TOTAL ANNUAL COSTS IN $1000

FOR INTEREST RATE OF 5 3/8 %

TOTAL ANNUAL CAPITAL	427	20345	43128	59611	74440	74440	82110	82110	82110	82110	82113
TOTAL ANNUAL O&M	0	2579	7104	13060	18196	20065	22059	23097	24237	24936	25709
TOTAL ANNUAL COSTS	427	22924	50232	69671	92636	94505	104169	105207	106347	107046	107822

FOR INTEREST RATE OF 7 %

TOTAL ANNUAL CAPITAL	531	25097	53161	69507	91069	91069	100418	100418	100418	100418	100422
TOTAL ANNUAL O&M	0	2579	7104	13060	18196	20065	22059	23097	24237	24936	25709
TOTAL ANNUAL COSTS	531	27676	60265	82567	109265	111134	122477	123515	124655	125354	126131

FOR INTEREST RATE OF 10 %

TOTAL ANNUAL CAPITAL	744	34944	73954	96241	125554	125554	136386	138386	138386	136386	138391
TOTAL ANNUAL O&M	0	2579	7104	13060	18196	20065	22059	23097	24237	24936	25709
TOTAL ANNUAL COSTS	744	37523	81058	109301	143750	145619	160445	161483	162623	163322	164139

TABLE V-7 (Continued)

PLAN A

TOTAL ANNUAL COSTS OF WASTEWATER AND STORMWATER TREATMENT

CAPITAL EXPENDITURES IN $1000

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL	RESIDUAL
PLANTS	35	0	154055	81570	207250	309337	0	328918	50	132813	87203	207250	1508446	557467
EXPAND TO LEVEL 1	35	0	82700	2450	0	0	0	19700	2450	61000	0	0	170300	69997
EXPAND TO LEVEL 2	25	0	0	0	185669	0	0	0	0	97669	0	88000	371338	148472
SLUDGE FACILITIES	35	0	57019	12779	12819	56508	0	253	0	57019	12779	12862	222038	72496
SEWERS	50	0	134715	125102	36883	67913	0	49133	0	0	0	0	413751	106126
DETENTION BASINS	50	0	183170	201770	22787	8052	0	6172	0	0	0	0	421951	72367
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	11525	0	0	0	0	0	0	0	0	0	0	11525	0
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	39	5026	7294	4130	21785	11100	0	6745	0	8575	0	13436	75091	31136
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		16551	618953	427801	487198	452910	0	410921	2500	359076	99982	318548	3194440	1035961

ANNUAL CAPITAL COSTS IN $1000 (AT 7%)

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	11927	18208	34166	58037	58037	82806	82806	81728	81728	81728
EXPAND TO LEVEL 1	35	0	6545	6755	6755	6755	6755	6755	6755	6755	6755	6755
EXPAND TO LEVEL 2	25	0	0	0	15175	15175	15175	15175	15175	15175	15175	15175
SLUDGE FACILITIES	35	0	4390	5374	6361	10711	10711	10731	10731	10731	10731	10734
SEWERS	50	0	9699	18706	21362	26252	26252	29789	29789	29789	29789	29789
DETENTION BASINS	50	0	13198	27715	29356	29936	29936	30380	30380	30380	30380	30380
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	33	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	50	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	50	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	10	0	0	0	0	0	0	0	0	0	0	0
LAND PURCHASE & PREP	50	829	829	829	829	829	829	829	829	829	829	829
IRRIGATION SYSTEMS	33	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	50	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	39	0	816	1200	1258	3601	3601	4093	4093	4719	4719	4665
MISCELLANEOUS	33	0	0	0	0	0	0	0	0	0	0	0
TOTAL AT 5 3/8%		668	38836	64325	94777	124548	124548	148757	148757	148367	148367	148325
TOTAL AT 7 %		829	47397	78792	115266	151300	151300	180563	180563	180111	180112	180060
TOTAL AT 10 %		1164	65114	108742	157631	206627	206627	246375	246375	245785	245785	245714

ANNUAL OPERATION AND MAINTENANCE COSTS IN $1000

ITEM	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL
PLANTS	27543	33162	39006	54618	70704	73041	78081	82456	86891	90640	94445	3252659
SLUDGE	3419	3835	4848	3949	2999	3037	3433	3648	3931	4115	4346	176389
SEWERS	0	656	1261	1433	1753	1854	1973	1973	1973	1973	1973	75325
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY PUMPING	0	0	0	0	0	0	0	0	0	0	0	0
FORCE MAINS	0	0	0	0	0	0	0	0	0	0	0	0
STORAGE RESERVOIRS	0	0	0	0	0	0	0	0	0	0	0	0
RESERVOIR AER & CL	0	0	0	0	0	0	0	0	0	0	0	0
IRRIGATION SYSTEMS	0	0	0	0	0	0	0	0	0	0	0	0
DRAINAGE SYSTEMS	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE MANAGEMENT	0	1993	2265	2584	1364	1438	1520	1607	1703	1821	1949	87660
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	30962	39647	47380	62584	76520	79370	85007	89684	94498	98549	102713	3592033

TOTAL ANNUAL COSTS IN $1000

FOR INTEREST RATE OF 5 3/8 %

TOTAL ANNUAL CAPITAL	668	38836	64325	94777	124548	124548	148757	148757	148367	148367	148325
TOTAL ANNUAL O&M	30962	39647	47380	62584	76520	79370	85007	89684	94498	98549	102713
TOTAL ANNUAL COSTS	31630	78483	111705	157361	201068	203918	233764	238441	242865	246916	251038

FOR INTEREST RATE OF 7 %

TOTAL ANNUAL CAPITAL	829	47397	78792	115266	151300	151300	180563	180563	180111	180112	180060
TOTAL ANNUAL O&M	30962	39647	47380	62584	76520	79370	85007	89684	94498	98549	102713
TOTAL ANNUAL COSTS	31791	87044	126172	177850	227820	230670	265570	270247	274609	278661	282773

FOR INTEREST RATE OF 10 %

TOTAL ANNUAL CAPITAL	1164	65114	108742	157631	206627	206627	246375	246375	245785	245785	245714
TOTAL ANNUAL O&M	30962	39647	47380	62584	76520	79370	85007	89684	94498	98549	102713
TOTAL ANNUAL COSTS	32126	104761	156122	220215	283147	285997	331382	336059	340283	344334	348427

TABLE V-8

PLAN 8

ANNUAL COSTS OF MUNICIPAL/INDUSTRIAL WASTEWATER TREATMENT

CAPITAL EXPENDITURES IN $1000

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL	RESIDUAL
PLANTS	35	0	68893	4160	44600	37677	0	257498	0	467C2	9840	48500	523770	201963
EXPAND TO LEVEL 1	35	0	82400	2450	0	0	0	19400	2450	63000	0	0	169700	44438
EXPAND TO LEVEL 2	25	0	0	0	170620	0	0	0	0	42620	0	68000	341240	137572
SLUDGE FACILITIES	35	0	45930	960	11500	46050	0	0	0	45930	960	11500	162770	51532
SEWERS	50	0	43130	32676	0	24303	0	720	0	0	0	0	100832	20986
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	9570	0	0	940	7038	0	0	0	9570	0	27118	11025
SECONDARY PUMPING	33	0	494	1954	0	1993	0	0	0	494	1954	0	6889	2274
FORCE MAINS	50	0	587	3522	0	0	0	0	0	0	0	0	4109	929
STORAGE RESERVOIRS	50	0	2267	9700	0	4615	0	5313	0	5173	0	0	27068	9161
RESERVOIR AER & CL	10	0	532	2251	0	3719	0	4602	0	5499	0	5523	22126	5523
LAND PURCHASE & PREP	50	3470	734	2587	377	773	563	844	560	767	611	0	3776	7917
IRRIGATION SYSTEMS	33	0	513	2150	242	810	337	502	350	974	2506	243	6627	3594
DRAINAGE SYSTEMS	50	0	537	1595	293	503	352	549	342	522	395	0	5085	1787
SLUDGE MANAGEMENT	39	5526	3974	400	21765	7722	905	2950	0	3455	1943	5176	53333	23092
MISCELLANEOUS	33	0	1078	408	52	218	778	116	75	136	1147	5	4013	0
TOTAL		8996	260689	64816	253369	129320	9973	292496	3777	257272	28923	158947	1460478	524193

ANNUAL CAPITAL COSTS IN $1000 (AT 7%)

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	5369	5690	9424	12376	12376	31646	31646	30649	30649	30649
EXPAND TO LEVEL 1	35	0	6519	6730	6730	6730	6730	6730	6730	6730	6730	6730
EXPAND TO LEVEL 2	25	0	0	0	13681	13881	13881	13881	13881	13881	13881	13881
SLUDGE FACILITIES	35	0	3534	3608	4493	8039	8039	8039	8039	8039	8039	8039
SEWERS	50	0	3105	5457	5457	7207	7207	7259	7259	7259	7259	7259
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	717	717	788	1316	1316	1316	1316	1316	1316
SECONDARY PUMPING	33	0	0	38	190	346	346	346	346	346	346	346
FORCE MAINS	50	0	0	42	295	295	295	295	295	295	295	295
STORAGE RESERVOIRS	50	0	0	164	863	1195	1195	1577	1577	1950	1950	1950
RESERVOIR AER & CL	10	0	0	60	436	583	583	601	720	966	863	984
LAND PURCHASE & PREP	50	285	285	343	529	612	652	713	753	811	855	855
IRRIGATION SYSTEMS	33	0	0	40	207	289	316	355	382	418	446	446
DRAINAGE SYSTEMS	50	0	0	38	153	210	235	275	300	337	366	366
SLUDGE MANAGEMENT	39	0	432	686	743	2840	2906	3121	3121	3374	3511	3456
MISCELLANEOUS	33	0	0	84	115	136	197	206	212	139	196	193
TOTAL AT 5 3/8%		230	15968	19605	36393	46204	46820	63682	63689	63636	63784	63845
TOTAL AT 7 %		285	19247	23702	44242	55535	56282	76567	76585	76515	76708	76770
TOTAL AT 10 %		400	26023	32167	59374	74740	75758	103148	103188	103079	103362	103425

ANNUAL OPERATION AND MAINTENANCE COSTS IN $1000

ITEM	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL
PLANTS	27523	30978	31487	40815	51265	51399	54184	56905	59638	62026	64428	2353163
SLUDGE	3402	3748	3980	2651	1060	1120	1183	1242	1304	1354	1408	94135
SEWERS	0	206	367	367	489	490	492	492	492	492	492	19920
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	514	593	691	845	1010	1068	1136	1190	1242	38223
SECONDARY PUMPING	0	0	45	252	366	389	432	465	496	526	561	15785
FORCE MAINS	0	0	4	30	30	30	30	30	30	30	30	1134
STORAGE RESERVOIRS	0	0	11	60	80	83	102	107	124	125	130	3549
RESERVOIR AER & CL	0	0	49	168	222	236	286	304	348	355	369	10516
IRRIGATION SYSTEMS	0	0	32	156	200	213	246	260	296	301	303	9039
DRAINAGE SYSTEMS	0	0	8	40	49	52	60	65	72	75	77	2211
SLUDGE MANAGEMENT	0	1638	1872	2079	757	815	874	938	945	977	1015	59518
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	30925	36620	38412	47267	55265	55735	58989	61938	64974	67544	70355	2607298

TOTAL ANNUAL COSTS IN $1000

FOR INTEREST RATE OF 5 3/8 %

TOTAL ANNUAL CAPITAL	230	15968	19605	36393	46204	46820	63682	63689	63636	63784	63845
TOTAL ANNUAL O&M	30925	36620	38412	47267	55265	55735	58989	61938	64974	67544	70355
TOTAL ANNUAL COSTS	31155	52588	58017	84160	101469	102555	122671	125627	128610	131328	133900

FOR INTEREST RATE OF 7 %

TOTAL ANNUAL CAPITAL	285	19247	23702	44242	55535	56282	76567	76585	76515	76708	76770
TOTAL ANNUAL O&M	30925	36620	38412	47267	55265	55735	58989	61938	64974	67544	70355
TOTAL ANNUAL COSTS	31210	55867	62114	91509	110800	112017	135556	138523	141489	144252	146625

FOR INTEREST RATE OF 10 %

TOTAL ANNUAL CAPITAL	400	26023	32167	59374	74740	75758	103148	103188	103079	103362	103425
TOTAL ANNUAL O&M	30925	36620	38412	47267	55265	55735	58989	61938	64974	67544	70355
TOTAL ANNUAL COSTS	31325	62643	70579	106641	130005	131493	162137	165126	168053	170906	173780

PLAN B

ANNUAL COSTS OF STORMWATER TREATMENT

CAPITAL EXPENDITURES IN $1000

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL	RESIDUAL
PLANTS	35	0	59300	69910	132960	187530	0	20370	0	59300	69910	132960	732240	270143
EXPAND TO LEVEL 1	35	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	5697	11046	1263	390	0	74	0	5697	11045	1263	36475	14468
SEWERS	50	0	88517	94629	30954	40714	0	52113	0	0	0	0	306927	84497
DETENTION BASINS	50	0	183170	193575	22767	9349	0	9406	0	0	0	0	418267	73191
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	1817	0	25	0	5	0	1647	694
SECONDARY PUMPING	33	0	12	2031	0	2637	0	3205	0	12	2090	0	9987	3391
FORCE MAINS	50	0	68	2620	0	904	0	1826	0	0	0	0	5418	2065
STORAGE RESERVOIRS	50	0	0	3654	0	4996	0	6128	0	923	0	0	15691	7169
RESERVOIR AER & CL	10	0	0	401	0	857	0	1453	0	1628	0	1638	5977	1650
LAND PURCHASE & PREP	50	7140	0	1069	0	720	26	1053	73	322	136	0	10539	3401
IRRIGATION SYSTEMS	33	0	3	1023	0	822	24	924	33	260	1076	0	4165	1519
DRAINAGE SYSTEMS	50	0	0	656	0	527	24	675	56	246	88	0	2272	1014
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	180	0	133	151	174	14	55	70	0	777	156
TOTAL		7140	336767	380994	187944	249569	2042	97401	201	68443	84420	135861	1550782	463848

ANNUAL CAPITAL COSTS IN $1000 (AT 7%)

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	4566	9949	20187	34626	34626	36195	36195	36195	36195	36195
EXPAND TO LEVEL 1	35	0	0	0	0	0	0	0	0	0	0	0
EXPAND TO LEVEL 2	25	0	0	0	0	0	0	0	0	0	0	0
SLUDGE FACILITIES	35	0	438	1285	1386	1416	1416	1422	1422	1422	1422	1422
SEWERS	50	0	6373	13186	15415	18346	18346	22098	22098	22098	22098	22098
DETENTION BASINS	50	0	13198	27125	28764	29437	29437	30115	30115	30115	30115	30115
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	0	0	0	136	136	138	138	138	138
SECONDARY PUMPING	33	0	0	0	159	365	365	615	615	615	619	619
FORCE MAINS	50	0	0	4	193	258	258	390	390	390	390	390
STORAGE RESERVOIRS	50	0	0	0	277	636	636	1077	1077	1144	1144	1144
RESERVOIR AER & CL	10	0	0	0	66	143	143	242	242	271	271	273
LAND PURCHASE & PREP	50	514	514	514	591	642	644	720	725	749	758	758
IRRIGATION SYSTEMS	33	0	0	0	80	144	146	218	220	240	244	244
DRAINAGE SYSTEMS	50	0	0	0	47	85	86	135	139	157	163	163
SLUDGE MANAGEMENT	39	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	33	0	0	0	14	24	36	49	50	55	46	46
TOTAL AT 5 3/8%		414	20331	42233	54688	70338	70464	76276	76288	76423	76436	76437
TOTAL AT 7 %		514	25080	52070	67183	86127	86281	93417	93432	93594	93609	93611
TOTAL AT 10 %		721	34921	72457	93082	118861	119070	128946	128967	129184	129206	129208

ANNUAL OPERATION AND MAINTENANCE COSTS IN $1000

ITEM	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL
PLANTS	0	2096	5462	10364	14501	15450	16451	17144	17887	18252	18661	612200
SLUDGE	0	52	726	1102	1405	1616	1887	1991	2153	2237	2357	67785
SEWERS	0	434	890	1033	1216	1323	1450	1450	1450	1450	1450	54055
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	0	29	55	113	127	135	143	150	156	4088
SECONDARY PUMPING	0	0	1	148	313	302	532	550	567	582	597	16271
FORCE MAINS	0	0	0	14	17	17	28	28	28	28	28	848
STORAGE RESERVOIRS	0	0	0	19	44	44	75	75	76	79	79	2218
RESERVOIR AER & CL	0	0	0	28	58	61	91	93	108	111	112	2961
IRRIGATION SYSTEMS	0	0	0	52	109	116	176	183	196	197	200	5547
DRAINAGE SYSTEMS	0	0	0	9	16	17	25	25	30	31	32	803
SLUDGE MANAGEMENT	0	0	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	0	0	0	9	16	24	32	32	36	36	36	978
TOTAL	356	2582	7079	12807	17750	19083	20874	21706	22674	23153	23708	767754

TOTAL ANNUAL COSTS IN $1000

FOR INTEREST RATE OF 5 3/8 %

TOTAL ANNUAL CAPITAL	414	20331	42233	54688	70338	70464	76276	76288	76423	76436	76437
TOTAL ANNUAL O&M	356	2582	7079	12807	17750	19083	20874	21706	22674	23153	23708
TOTAL ANNUAL COSTS	770	22913	49312	67495	88088	89547	97150	97994	99097	99589	100145

FOR INTEREST RATE OF 7 %

TOTAL ANNUAL CAPITAL	514	25080	52070	67183	86127	86281	93417	93432	93594	93609	93611
TOTAL ANNUAL O&M	356	2582	7079	12807	17750	19083	20874	21706	22674	23153	23708
TOTAL ANNUAL COSTS	870	27662	59149	79990	103877	105364	114291	115138	116268	116762	117319

FOR INTEREST RATE OF 10 %

TOTAL ANNUAL CAPITAL	721	34921	72457	93082	118861	119070	128946	128967	129184	129206	129208
TOTAL ANNUAL O&M	356	2582	7079	12807	17750	19083	20874	21706	22674	23153	23708
TOTAL ANNUAL COSTS	1077	37503	79536	105889	136611	138153	149820	150673	151858	152359	152915

TABLE V-8 (Continued)

PLAN B

TOTAL ANNUAL COSTS OF WASTEWATER AND STORMWATER TREATMENT

CAPITAL EXPENDITURES IN $1000

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL	RESIDUAL
PLANTS	35	0	129193	74070	181460	225207	0	277868	0	108002	79750	181460	1256010	472106
EXPAND TO LEVEL 1	35	0	82400	2450	0	0	0	19400	2450	63000	0	0	169700	49838
EXPAND TO LEVEL 2	25	0	0	0	170620	0	0	0	0	82620	0	88000	341240	137972
SLUDGE FACILITIES	35	0	51597	12006	12763	66440	0	74	0	51597	12005	12763	199245	66403
SEWERS	50	0	131647	127306	30954	65017	0	52833	0	0	0	0	407759	105583
DETENTION BASINS	50	0	183170	193575	22767	9349	0	9406	0	0	0	0	418267	73181
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	9573	0	0	940	8855	0	25	0	9575	0	28965	11719
SECONDARY PUMPING	33	0	506	3985	0	4630	0	3205	0	506	4044	0	16876	5865
FORCE MAINS	50	0	655	6142	0	904	0	1826	0	0	0	0	9527	2994
STORAGE RESERVOIRS	50	0	2287	13554	0	9601	0	11441	0	6096	0	0	42979	16330
RESERVOIR AER & CL	10	0	532	2652	0	4576	0	6055	0	7127	0	7161	28103	7173
LAND PURCHASE & PREP	50	11110	794	3956	377	1493	589	1897	633	1119	747	0	14317	11318
IRRIGATION SYSTEMS	33	0	516	3173	242	1632	361	1426	383	1234	3582	243	12792	5113
DRAINAGE SYSTEMS	50	0	537	2251	293	1027	376	1224	398	768	463	0	7357	2601
SLUDGE MANAGEMENT	39	5026	3974	400	21785	7722	905	2950	0	3455	1940	5176	53333	23092
MISCELLANEOUS	33	0	1078	586	52	351	929	290	89	191	1217	5	4790	156
TOTAL		16136	597456	445810	441313	378389	12015	389695	3978	325715	113343	294808	3011260	988041

ANNUAL CAPITAL COSTS IN $1000 (AT 7%)

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	9936	15639	29611	47003	47003	67842	67842	66845	66845	66845
EXPAND TO LEVEL 1	35	0	6519	6730	6730	6730	6730	6730	6730	6730	6730	6730
EXPAND TO LEVEL 2	25	0	0	0	13881	13881	13881	13881	13881	13881	13881	13881
SLUDGE FACILITIES	35	0	3972	4897	5879	9455	9455	9461	9461	9461	9461	9461
SEWERS	50	0	9478	18644	20872	25553	25553	29357	29357	29357	29357	29357
DETENTION BASINS	50	0	13188	27125	26764	29437	29437	30115	30115	30115	30115	30115
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	39	0	0	717	717	788	1452	1452	1454	1454	1454	1454
SECONDARY PUMPING	33	0	0	39	350	711	711	961	961	962	966	966
FORCE MAINS	50	0	0	47	489	554	554	685	685	685	685	685
STORAGE RESERVOIRS	50	0	0	164	1140	1831	1831	2655	2655	3094	3094	3094
RESERVOIR AER & CL	10	0	0	60	503	726	726	1044	963	1237	1135	1257
LAND PURCHASE & PREP	50	799	799	857	1120	1254	1297	1433	1479	1560	1613	1613
IRRIGATION SYSTEMS	33	0	0	40	257	433	462	573	603	659	691	691
DRAINAGE SYSTEMS	50	0	0	38	200	295	322	410	439	494	529	529
SLUDGE MANAGEMENT	39	0	432	686	743	2840	2906	3121	3121	3374	3511	3456
MISCELLANEOUS	33	0	0	84	129	161	233	256	263	194	243	239
TOTAL AT 5 3/8%		644	36299	61838	91582	116542	117285	139958	139978	140059	140220	140283
TOTAL AT 7 %		799	44327	75773	111425	141663	142563	169985	170017	170109	170317	170381
TOTAL AT 10 %		1122	60944	104624	152456	193602	194829	232095	232155	232263	232568	232633

ANNUAL OPERATION AND MAINTENANCE COSTS IN $1000

ITEM	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL
PLANTS	27523	33374	36949	51179	65766	66849	70635	74049	77525	80278	83089	2965368
SLUDGE	3432	3800	4706	3753	2465	2736	3070	3233	3457	3591	3765	161920
SEWERS	0	640	1257	1400	1705	1813	1942	1942	1942	1942	1942	73975
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	0	0	0	0	0	0	0	0	0	0
AERATED LAGOONS	0	0	514	622	746	958	1137	1203	1279	1340	1398	42311
SECONDARY PUMPING	0	0	46	400	679	691	964	1015	1063	1108	1158	32056
FORCE MAINS	0	0	4	44	47	47	58	58	58	56	58	1982
STORAGE RESERVOIRS	0	0	11	79	124	127	177	182	200	204	209	5667
RESERVOIR AER & CL	0	0	49	196	280	297	377	397	456	466	481	13477
IRRIGATION SYSTEMS	0	0	32	208	309	329	422	443	492	498	533	14586
DRAINAGE SYSTEMS	0	0	8	49	65	69	85	90	102	106	109	3014
SLUDGE MANAGEMENT	0	1688	1872	2079	757	815	874	908	945	977	1015	59518
MISCELLANEOUS	0	0	0	9	16	24	32	32	36	36	36	976
TOTAL	31291	39202	45491	60074	73015	74818	79803	83644	87648	90697	93763	3375052

TOTAL ANNUAL COSTS IN $1000

FOR INTEREST RATE OF 5 3/8 %

TOTAL ANNUAL CAPITAL	644	36299	61838	91582	116542	117285	139958	139978	140059	140220	140283
TOTAL ANNUAL O&M	31291	39202	45491	60074	73015	74818	79803	83644	87648	90697	93763
TOTAL ANNUAL COSTS	31925	75501	107329	151656	189557	192103	219821	223622	227707	230917	234046

FOR INTEREST RATE OF 7 %

TOTAL ANNUAL CAPITAL	799	44327	75773	111425	141663	142563	169985	170017	170109	170317	170381
TOTAL ANNUAL O&M	31291	39202	45491	60074	73015	74818	79803	83644	87648	90697	93763
TOTAL ANNUAL COSTS	32090	83529	121264	171499	214678	217381	249848	253661	257757	261014	264144

FOR INTEREST RATE OF 10 %

TOTAL ANNUAL CAPITAL	1122	60944	104624	152456	193602	194829	232095	232155	232263	232568	232633
TOTAL ANNUAL O&M	31291	39202	45491	60074	73015	74818	79803	83644	87648	90697	93763
TOTAL ANNUAL COSTS	32403	100146	150115	212530	266617	269647	311898	315799	319911	323265	326396

TABLE V-9

PLAN C

ANNUAL COSTS OF MUNICIPAL/INDUSTRIAL WASTEWATER TREATMENT

CAPITAL EXPENDITURES IN $1000

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL RESIDUAL
PLANTS	35	0	60134	9660	44500	80	0	3900	0	1182	10	48500	171966 51022
EXPAND TO LEVEL 1	35	0	82400	1050	0	0	0	0	0	8000	0	0	91450 5711
EXPAND TO LEVEL 2	25	0	0	0	22000	0	0	0	0	22000	0	0	44000 13200
SLUDGE FACILITIES	35	0	46600	960	11500	0	0	0	0	8800	0	11500	79360 17783
SEWERS	50	0	43130	39820	0	24303	0	720	0	0	0	0	127973 22414
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0	0 0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0	0 0
SHAFTS & TUNNELS	50	0	48884	322200	0	0	0	0	0	0	0	0	371084 55933
AERATED LAGOONS	39	0	12420	0	0	60643	8783	8630	0	0	12420	0	102893 32112
SECONDARY PUMPING	33	0	494	22394	0	7378	0	0	0	494	2394	20000	53154 24684
FORCE MAINS	50	0	587	6582	0	0	0	0	0	0	0	0	7169 1670
STORAGE RESERVOIRS	50	0	2287	48780	0	14450	0	14443	0	12903	0	0	92863 35520
RESERVOIR AER & CL	10	0	532	6758	0	8735	0	10222	0	11541	0	11565	49354 11565
LAND PURCHASE & PREP	50	2190	794	56857	517	3777	3538	3524	3170	2833	2647	0	80960 77668
IRRIGATION SYSTEMS	33	0	513	50771	442	4034	2804	2738	2586	2678	6321	46973	119900 55552
DRAINAGE SYSTEMS	50	0	537	43645	379	2783	2632	2564	2349	2080	1952	0	56920 20467
SLUDGE MANAGEMENT	39	3004	12837	7260	342	2322	1139	10877	0	3600	11652	2700	55953 23131
MISCELLANEOUS	33	0	1363	9822	78	6733	1510	1432	521	462	1882	9056	32879 13416
TOTAL		5194	313512	626579	83757	135236	20466	59050	8626	76793	39258	150294	1505878 504848

ANNUAL CAPITAL COSTS IN $1000 (AT 7%)

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	4630	5374	9108	9114	9114	9415	9415	4875	4132	4132
EXPAND TO LEVEL 1	35	0	6519	6609	6609	6609	6609	4941	4851	616	616	616
EXPAND TO LEVEL 2	25	0	0	0	1892	1892	1892	1892	1892	1892	1892	1892
SLUDGE FACILITIES	35	0	3588	3662	4547	4547	4547	4547	4547	1636	1562	1562
SEWERS	50	0	3105	5971	5971	7721	7721	7773	7773	7773	7773	7773
DETENTION BASINS	50	0	0	0	0	0	0	0	0	0	0	0
TEMPORARY PUMPS	4	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	3519	26718	26718	26718	26719	26718	26718	26719	26718
AERATED LAGOONS	39	0	0	931	931	5479	6138	6785	6785	6785	6785	6785
SECONDARY PUMPING	33	0	0	38	1765	2360	2360	2360	2360	2360	2360	2360
FORCE MAINS	50	0	0	42	516	516	516	516	516	516	516	516
STORAGE RESERVOIRS	50	0	0	164	3676	4717	4717	5757	5757	6686	6686	6686
RESERVOIR AER & CL	10	0	0	60	1189	1925	1421	1739	1659	1975	1872	1993
LAND PURCHASE & PREP	50	157	157	214	4308	4617	4872	5126	5354	5558	5748	5748
IRRIGATION SYSTEMS	33	0	0	40	4000	4349	4572	4786	4987	5156	5317	5317
DRAINAGE SYSTEMS	50	0	0	38	3181	3408	3598	3782	3951	4101	4242	4242
SLUDGE MANAGEMENT	39	0	915	1390	1759	1933	2019	2835	2835	3120	2694	2805
MISCELLANEOUS	33	0	0	106	872	1403	1521	1633	1673	1605	1690	1686
TOTAL AT 5 3/8%		127	15693	23201	63157	71651	72434	74257	74628	66561	66076	66107
TOTAL AT 7 %		157	18916	28166	77069	87317	88342	90611	91079	81378	80811	80838
TOTAL AT 10 %		221	25608	38444	105785	119650	121175	124380	125049	111950	111211	111227

ANNUAL OPERATION AND MAINTENANCE COSTS IN $1000

ITEM	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL
PLANTS	27407	30773	30514	21146	20947	21226	10672	11495	12334	13278	14234	930913
SLUDGE	3416	3742	3914	2627	2323	2436	231	249	269	289	311	66491
SEWERS	0	206	402	402	524	525	527	527	527	527	527	21320
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	244	2363	2421	2454	2487	2515	2543	2565	2586	91034
AERATED LAGOONS	0	0	733	828	7216	7855	8454	8748	9052	9271	9433	268750
SECONDARY PUMPING	0	0	45	6899	7791	8163	8554	8889	9223	9486	9746	302306
FORCE MAINS	0	0	4	45	45	45	45	45	45	45	45	1667
STORAGE RESERVOIRS	0	0	11	255	324	327	391	396	452	453	458	13489
RESERVOIR AER & CL	0	0	36	990	1129	1197	1302	1369	1462	1504	1551	46610
IRRIGATION SYSTEMS	0	0	32	2443	2624	2757	2895	3013	3129	3210	3216	102904
DRAINAGE SYSTEMS	0	0	8	569	606	641	674	706	731	753	755	23879
SLUDGE MANAGEMENT	0	1291	1616	1738	845	913	1229	1300	1388	1457	1531	63079
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	30823	36012	37616	40845	47336	49412	38397	40254	42178	43862	44448	1952502

TOTAL ANNUAL COSTS IN $1000

FOR INTEREST RATE OF 5 3/8 %

TOTAL ANNUAL CAPITAL	127	15693	23201	63157	71651	72434	74257	74628	66561	66076	66107
TOTAL ANNUAL O&M	30823	36012	37616	40845	47336	49412	38397	40254	42178	43862	44448
TOTAL ANNUAL COSTS	30950	51695	60817	104002	118987	121846	112654	114882	108739	109938	110555

FOR INTEREST RATE OF 7 %

TOTAL ANNUAL CAPITAL	157	18916	28166	77069	87317	88342	90611	91079	81378	80811	80838
TOTAL ANNUAL O&M	30823	36012	37616	40845	47336	49412	38397	40254	42178	43862	44448
TOTAL ANNUAL COSTS	30980	54928	65782	117914	134653	137754	129008	131333	123556	124673	125286

FOR INTEREST RATE OF 10 %

TOTAL ANNUAL CAPITAL	221	25608	38444	105785	119650	121175	124380	125049	111950	111211	111227
TOTAL ANNUAL O&M	30823	36012	37616	40845	47336	49412	38397	40254	42178	43862	44448
TOTAL ANNUAL COSTS	31044	61620	76060	146630	166986	170587	162777	165303	154128	155073	155675

TABLE V-9 (Continued)

PLAN C

ANNUAL COSTS OF STORMWATER TREATMENT

CAPITAL EXPENDITURES IN $1000

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL	RESIDUAL
PLANTS	35	0	29340	45645	61350	123746	1886	21930	1462	16768	32584	48641	383592	110704
EXPAND TO LEVEL 1	35	0	225	545	790	126	103	85	47	93	94	98	2246	0
EXPAND TO LEVEL 2	25	0	565	575	1255	252	256	261	261	261	261	261	4208	0
SLUDGE FACILITIES	35	0	1493	1657	0	0	0	0	0	1493	0	0	4643	2271
SEWERS	50	0	88517	53305	72478	40714	0	52113	0	0	0	0	307127	88799
DETENTION BASINS	50	0	94930	63410	67005	9349	0	9406	0	0	0	0	244100	51406
TEMPORARY PUMPS	4	0	2768	0	0	0	0	0	0	0	0	0	2768	0
SHAFTS & TUNNELS	50	0	20930	78660	0	0	0	0	0	0	0	0	99590	25034
AERATED LAGOONS	39	0	0	0	0	12300	1817	1370	25	0	5	0	15517	4202
SECONDARY PUMPING	33	0	12	6031	0	3637	0	3205	0	12	2090	4000	18987	7462
FORCE MAINS	50	0	68	2660	0	904	0	1926	0	0	0	0	5458	2075
STORAGE RESERVOIRS	50	0	0	10969	0	6356	0	7658	0	1553	0	0	26536	11129
RESERVOIR AER & CL	10	0	0	1035	0	1507	0	2146	0	2321	0	2331	9340	2343
LAND PURCHASE & PREP	50	7496	0	11918	0	1078	26	1411	73	660	136	0	22818	15324
IRRIGATION SYSTEMS	33	0	3	10753	0	1670	24	1714	33	548	1076	9733	25551	11638
DRAINAGE SYSTEMS	50	0	0	9136	0	1210	24	1408	56	513	88	0	12435	4314
SLUDGE MANAGEMENT	39	0	0	4305	0	346	0	356	0	68	0	0	5075	666
MISCELLANEOUS	33	0	0	2095	0	1431	151	419	14	115	70	1885	6150	900
TOTAL		7496	238851	302869	202918	204626	4287	105308	2011	24425	36404	66946	1196141	338487

ANNUAL CAPITAL COSTS IN $1000 (AT 7%)

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	1399	4910	9676	20044	20189	21878	21991	21883	20580	19860
EXPAND TO LEVEL 1	35	0	3	28	80	144	153	157	139	95	39	39
EXPAND TO LEVEL 2	25	0	9	58	119	227	249	262	236	197	111	112
SLUDGE FACILITIES	35	0	114	242	242	242	242	242	242	242	114	114
SEWERS	50	0	6373	10211	15429	18361	18361	22113	22113	22113	22113	22113
DETENTION BASINS	50	0	6834	11400	16224	16897	16897	17575	17575	17575	17575	17575
TEMPORARY PUMPS	4	0	0	816	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	1506	7170	7170	7170	7170	7170	7170	7170	7170
AERATED LAGOONS	39	0	0	0	0	922	1058	1161	1163	1163	1163	1163
SECONDARY PUMPING	33	0	0	0	471	755	1005	1005	1005	1005	1009	1009
FORCE MAINS	50	0	0	4	196	261	261	392	392	392	392	392
STORAGE RESERVOIRS	50	0	0	0	789	1247	1247	1798	1798	1910	1910	1910
RESERVOIR AER & CL	10	0	0	0	172	357	251	358	358	387	387	389
LAND PURCHASE & PREP	50	539	539	539	1397	1475	1477	1578	1584	1633	1642	1642
IRRIGATION SYSTEMS	33	0	0	0	838	969	971	1104	1107	1150	1154	1154
DRAINAGE SYSTEMS	50	0	0	0	657	744	746	848	852	888	895	895
SLUDGE MANAGEMENT	39	0	0	0	322	348	348	375	375	380	380	380
MISCELLANEOUS	33	0	0	0	161	272	284	317	318	327	318	318
TOTAL AT 5 3/8%		434	12344	24207	43798	57417	57592	63845	63913	63987	62938	62092
TOTAL AT 7 %		539	15275	29721	53952	70444	70668	78340	78424	78518	77262	76243
TOTAL AT 10 %		757	21347	41139	74977	97419	97745	108353	108470	108605	106920	105543

ANNUAL OPERATION AND MAINTENANCE COSTS IN $1000

ITEM	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL
PLANTS	0	387	2006	4527	5639	6013	6433	6501	6612	6855	7138	231480
SLUDGE	0	9	408	766	972	1147	1374	1465	1606	1683	1796	46755
SEWERS	0	329	574	782	964	1067	1189	1189	1189	1189	1189	42915
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	105	409	616	620	627	632	638	640	642	19959
AERATED LAGOONS	0	0	0	29	1357	1473	1545	1599	1653	1670	1636	50128
SECONDARY PUMPING	0	0	1	1447	1828	1872	2157	2234	2310	2346	2393	73366
FORCE MAINS	0	0	0	14	17	17	28	28	28	28	28	848
STORAGE RESERVOIRS	0	0	0	55	87	87	125	125	129	132	132	3988
RESERVOIR AER & CL	0	0	400	604	841	854	897	911	939	947	953	32721
IRRIGATION SYSTEMS	0	0	0	510	605	612	710	717	744	745	743	23617
DRAINAGE SYSTEMS	0	0	0	115	131	132	149	149	157	158	159	5028
SLUDGE MANAGEMENT	0	0	0	536	574	597	620	644	668	672	677	21875
MISCELLANEOUS	0	0	0	103	175	183	203	203	210	210	210	6653
TOTAL	0	725	3494	10000	13909	14848	16238	16598	17084	17476	17741	561333

TOTAL ANNUAL COSTS IN $1000

FOR INTEREST RATE OF 5 3/8 %

TOTAL ANNUAL CAPITAL	434	12344	24207	43798	57417	57592	63845	63913	63987	62938	62092
TOTAL ANNUAL O&M	0	725	3494	10000	13909	14848	16238	16598	17084	17476	17741
TOTAL ANNUAL COSTS	434	13069	27701	53798	71326	72440	80083	80511	81071	80414	79833

FOR INTEREST RATE OF 7 %

TOTAL ANNUAL CAPITAL	539	15275	29721	53952	70444	70669	78340	78424	78518	77262	76243
TOTAL ANNUAL O&M	0	725	3494	10000	13909	14848	16238	16598	17084	17476	17741
TOTAL ANNUAL COSTS	539	16000	33215	63952	84353	85516	94578	95022	95602	94738	93984

FOR INTEREST RATE OF 10 %

TOTAL ANNUAL CAPITAL	757	21347	41139	74977	97419	97745	108353	108470	108605	106920	105543
TOTAL ANNUAL O&M	0	725	3494	10000	13909	14848	16238	16598	17084	17476	17741
TOTAL ANNUAL COSTS	757	22072	44633	84977	111328	112593	124591	125068	125689	124396	123284

TABLE V-9 (Continued)

PLAN C

TOTAL ANNUAL COSTS OF WASTEWATER AND STORMWATER TREATMENT

CAPITAL EXPENDITURES IN $1000

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL	RESIDUAL
PLANTS	35	0	59474	55506	109890	123826	1886	25830	1462	17950	32594	97141	555556	161726
EXPAND TO LEVEL 1	35	0	82625	1595	790	126	103	85	87	8093	94	98	93695	5711
EXPAND TO LEVEL 2	25	0	565	575	23255	252	256	261	261	22261	261	261	48208	13200
SLUDGE FACILITIES	35	0	46293	2617	11500	0	0	0	0	10293	0	11500	84203	19354
SEWERS	50	0	131647	93125	72678	65017	0	52833	0	0	0	0	415120	111213
DETENTION BASINS	50	0	94930	63410	67005	9349	0	9406	0	0	0	0	244100	51606
TEMPORARY PUMPS	4	0	2768	0	0	0	0	0	0	0	0	0	2768	0
SHAFTS & TUNNELS	50	0	99814	400860	0	0	0	0	0	0	0	0	472674	120967
AERATED LAGOONS	39	0	12423	0	0	72940	10600	10000	25	0	12425	0	118413	36314
SECONDARY PUMPING	33	0	506	23425	0	11015	0	3205	0	506	4484	24000	72141	32188
FORCE MAINS	50	0	655	9242	0	904	0	1826	0	0	0	0	12627	3745
STORAGE RESERVOIRS	50	0	2287	59749	0	20306	0	22101	0	14456	0	0	119359	46649
RESERVOIR AER & CL	10	0	532	7793	0	10243	0	12368	0	13852	0	13996	58864	13508
LAND PURCHASE & PREP	50	9686	794	68775	517	4655	3564	4935	3243	3513	2783	0	89776	92992
IRRIGATION SYSTEMS	33	0	516	61524	442	5704	2888	4452	2619	3226	7377	56733	145451	70393
DRAINAGE SYSTEMS	50	0	537	52781	378	3693	2656	3672	2405	2593	2040	0	71355	24781
SLUDGE MANAGEMENT	39	3004	12837	11585	342	2668	1139	11233	0	3868	11652	2700	61028	23797
MISCELLANEOUS	33	0	1363	11667	78	8164	1661	1651	535	597	1952	10941	39029	14316
TOTAL		12690	552363	929448	286675	339862	24753	164358	10637	101218	75662	217240	2702019	843335

ANNUAL CAPITAL COSTS IN $1000 (AT 7%)

ITEM	ITEM LIFE	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
PLANTS	35	0	6029	10284	18784	29159	29304	31293	31406	26758	25013	23993
EXPAND TO LEVEL 1	35	0	6523	6638	6690	6754	6763	5098	4990	711	655	655
EXPAND TO LEVEL 2	25	0	9	58	2011	2119	2141	2154	2128	2089	2003	2004
SLUDGE FACILITIES	35	0	3703	3904	4789	4789	4789	4789	4789	1879	1677	1677
SEWERS	50	0	9478	16183	21401	26082	26082	29886	29886	29886	29886	29886
DETENTION BASINS	50	0	6834	11400	16224	16897	16897	17575	17575	17575	17575	17575
TEMPORARY PUMPS	4	0	0	816	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	50	0	0	5026	33888	33888	33888	33888	33888	33888	33888	33888
AERATED LAGOONS	39	0	0	931	931	6402	7197	7947	7948	7948	7949	7949
SECONDARY PUMPING	33	0	0	39	2256	3115	3115	3365	3365	3366	3370	3370
FORCE MAINS	50	0	0	47	712	777	777	909	909	909	909	909
STORAGE RESERVOIRS	50	0	0	164	4466	5964	5964	7555	7555	8596	8596	8596
RESERVOIR AER & CL	10	0	0	60	1362	2283	1673	2098	2017	2362	2260	2382
LAND PURCHASE & PREP	50	697	697	754	5765	6093	6349	6705	6938	7191	7391	7391
IRRIGATION SYSTEMS	33	0	0	40	4339	5318	5543	5891	6095	6306	6471	6471
DRAINAGE SYSTEMS	50	0	0	38	3838	4153	4344	4630	4803	4990	5137	5137
SLUDGE MANAGEMENT	39	0	915	1390	2082	2282	2368	3210	3210	3500	3275	3186
MISCELLANEOUS	33	0	0	106	1033	1676	1805	1950	1992	1932	2009	2004
TOTAL AT 5 3/8%		561	28028	47408	106955	129068	130026	138102	138542	130549	129014	126139
TOTAL AT 7 %		697	34191	57867	131022	157761	159010	168951	169504	159896	158073	157081
TOTAL AT 10 %		978	46956	79583	180762	217070	218921	232734	233520	220556	219131	216771

ANNUAL OPERATION AND MAINTENANCE COSTS IN $1000

ITEM	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL
PLANTS	27407	31160	32520	25673	26586	27239	17105	17996	18946	20133	21372	1162393
SLUDGE	3416	3751	4322	3393	3295	3583	1605	1714	1874	1972	2107	135246
SEWERS	0	535	976	1184	1488	1592	1716	1716	1716	1716	1716	64235
TEMPORARY PUMPS	0	0	0	0	0	0	0	0	0	0	0	0
SHAFTS & TUNNELS	0	0	349	2772	3037	3074	3114	3147	3181	3205	3223	110393
AERATED LAGOONS	0	0	733	857	8573	9328	9999	10347	10705	10941	11174	319919
SECONDARY PUMPING	0	0	46	8346	9619	10035	10711	11123	11533	11832	12129	375572
FORCE MAINS	0	0	4	59	62	62	73	73	73	73	73	2535
STORAGE RESERVOIRS	0	0	11	310	411	414	516	521	581	585	590	17377
RESERVOIR AER & CL	0	0	436	1594	1970	2051	2199	2280	2401	2451	2524	79331
IRRIGATION SYSTEMS	0	0	32	2953	3229	3369	3605	3730	3873	3955	3994	126721
DRAINAGE SYSTEMS	0	0	8	664	737	773	823	855	888	911	914	28907
SLUDGE MANAGEMENT	0	1291	1616	2274	1419	1510	1849	1944	2056	2129	2208	84954
MISCELLANEOUS	0	0	0	103	175	183	203	203	210	210	210	6653
TOTAL	30823	36737	41110	50845	61245	64260	54635	56852	59262	61338	62189	2513335

TOTAL ANNUAL COSTS IN $1000

FOR INTEREST RATE OF 5 3/8 %

TOTAL ANNUAL CAPITAL	561	28028	47408	106955	129068	130026	138102	138542	130549	129014	126139
TOTAL ANNUAL O&M	30823	36737	41110	50845	61245	64260	54635	56852	59262	61338	62189
TOTAL ANNUAL COSTS	31384	64765	88518	157800	190313	194286	192737	195394	189811	190352	190388

FOR INTEREST RATE OF 7 %

TOTAL ANNUAL CAPITAL	697	34191	57867	131022	157761	159010	168951	169504	159896	158073	157081
TOTAL ANNUAL O&M	30823	36737	41110	50845	61245	64260	54635	56852	59262	61338	62189
TOTAL ANNUAL COSTS	31520	70928	98997	181867	219006	223270	223586	226356	219158	219411	219270

FOR INTEREST RATE OF 10 %

TOTAL ANNUAL CAPITAL	978	46956	79583	180762	217070	218921	232734	233523	220556	219131	216771
TOTAL ANNUAL O&M	30823	36737	41110	50845	61245	64260	54635	56852	59262	61338	62189
TOTAL ANNUAL COSTS	31801	83693	120693	231607	278315	283181	287369	290372	279818	279469	278960

TABLE V-10

PLAN A

ANNUAL COSTS OF MUNICIPAL/INDUSTRIAL WASTEWATER TREATMENT

CAPITAL EXPENDITURES IN $1000

PLANT	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL	RESIDUAL
RANDOLPH	8	1016	150	300	1055	0	155	0	1125	0	180	3989	1199
NEW KENT	520	12040	0	560	5680	0	7240	0	560	5680	0	32280	6807
BURTON	9	887	515	338	1535	0	155	0	1290	0	185	4914	1492
MANTUA	0	930	150	352	1155	0	155	0	1282	0	200	4224	1379
BUTTERNUT CREEK	12	1455	623	375	1745	0	180	0	1450	0	200	6040	1748
CHARDON	0	0	400	0	0	0	0	50	0	0	0	450	88
EAST CLARIDON	5	493	15	157	705	0	25	0	515	0	30	1945	507
TROY TOWNSHIP	5	373	15	158	781	0	25	0	516	0	30	1903	530
AUBURN TOWNSHIP	8	787	486	292	1285	0	155	0	1119	0	175	4307	1332
SHALERSBORO	0	0	0	0	0	0	0	0	0	0	0	0	0
RAVENNA	0	6106	0	2300	8500	0	1600	0	6630	0	0	25136	6422
AURORA CENTRAL	30	2125	1310	900	4360	0	325	0	3210	0	275	12535	3846
FAIRMOUNT ROAD	0	3070	410	1000	4158	0	345	0	3530	0	260	12773	3783
FOWLER'S MILL	20	2579	205	660	2430	0	255	0	2360	0	280	8789	2553
NEWBURY TOWNSHIP	15	1058	0	517	2570	0	0	0	1575	0	0	5735	1608
CHAGRIN FALLS	179	3275	871	1200	3295	0	1235	0	4540	0	705	15300	5262
CHAGRIN EAST BRANCH	20	2619	762	750	2305	0	225	0	2595	0	310	9586	2801
UPPER EAST BRANCH	0	0	0	0	0	0	0	0	0	0	0	0	0
HINCKLEY	0	0	0	0	0	0	0	0	0	0	0	0	0
MEDINA COUNTY	0	0	0	0	0	0	0	0	0	0	0	0	0
NEW MEDINA	0	0	0	0	0	0	0	0	0	0	0	0	0
MALLET CREEK	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVERPOOL	0	21850	500	7434	12575	0	575	0	12350	0	1750	57034	14774
MIDDLEFIELD	27	2430	392	950	2690	0	305	0	3255	0	400	10449	3296
MC FARLAND CREEK	0	6670	460	1200	4260	0	400	0	4065	0	280	17335	4427
AKRON	3244	17502	1200	82555	3600	0	3900	0	38800	0	63126	213927	91681
EUCLID	1110	8100	0	6560	13600	0	13900	0	12400	0	0	55670	15588
LAKEWOOD	750	8775	0	5560	3350	0	11400	0	12250	0	750	42835	13929
NORTH OLMSTED	0	0	0	0	0	0	0	0	0	0	0	0	0
ROCKY RIVER	400	115	2010	670	9200	0	8550	1050	685	960	400	24040	8050
WILLOUGHBY-EASTLAKE	0	1850	7906	4500	6434	0	7375	1400	6480	4150	0	40095	13910
EASTERLY	0	30500	1458	43000	17000	0	115353	0	58000	0	0	265311	85115
SOUTHERLY	2780	90765	23975	88000	36086	0	110130	0	71000	0	88000	510736	202200
WESTERLY	0	40000	0	0	19247	0	0	0	40000	0	0	99247	30353
WESTERN LAND TREATMENT	0	0	0	0	0	0	0	0	0	0	0	0	0
INTERIM PLANTS	33	14002	0	0	0	0	0	0	0	0	0	14035	0
STRIP-MINE PIPELINE	0	900	400	21000	0	0	2000	0	2500	0	900	27700	10010
TOTAL	9175	282272	44213	271288	169601	0	285963	2500	294082	10790	158436	1528320	534690

TABLE V-10 (Continued)

PLAN A

ANNUAL CAPITAL COSTS IN $1000 (AT 7%)

PLANT	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
RANDOLPH	0	77	87	113	194	194	205	205	220	220	220
NEW KENT	37	1005	1005	1053	1542	1542	1542	1542	1542	1542	1542
BURTON	0	68	105	134	250	250	262	262	280	280	280
MANTUA	0	70	81	112	200	200	211	211	226	226	226
BUTTERNUT CREEK	0	109	154	186	320	320	333	333	355	355	355
CHARDON	0	0	29	29	29	29	29	29	29	29	29
EAST CLARIDON	0	37	38	52	106	106	108	108	109	109	109
TROY TOWNSHIP	0	28	30	43	103	103	105	105	106	106	106
AUBURN TOWNSHIP	0	60	95	120	219	219	230	230	246	246	246
SHALERSBORO	0	0	0	0	0	0	0	0	0	0	0
RAVENNA	0	465	465	663	1317	1317	1417	1417	1417	1417	1417
AURORA CENTRAL	2	164	259	336	665	665	689	689	723	723	723
FAIRMOUNT ROAD	0	231	261	347	663	663	689	689	721	721	721
FOWLER'S MILL	1	194	208	265	451	451	470	470	498	498	498
NEWBURY TOWNSHIP	1	82	82	127	321	321	321	321	321	321	321
CHAGRIN FALLS	12	262	325	428	680	680	769	769	825	825	825
CHAGRIN EAST BRANCH	1	197	252	317	493	493	510	510	536	536	536
UPPER EAST BRANCH	0	0	0	0	0	0	0	0	0	0	0
HINCKLEY	0	0	0	0	0	0	0	0	0	0	0
MEDINA COUNTY	0	0	0	0	0	0	0	0	0	0	0
NEW MEDINA	0	0	0	0	0	0	0	0	0	0	0
MALLET CREEK	0	0	0	0	0	0	0	0	0	0	0
LIVERPOOL	0	1615	1651	2237	3203	3203	3245	3245	3293	3293	3293
MIDDLEFIELD	1	186	215	297	503	503	525	525	554	554	554
MC FARLAND CREEK	0	492	526	629	955	955	984	984	1019	1019	1019
AKRON	8	1538	1667	8220	8479	8479	8779	8779	8779	8779	8779
EUCLID	25	698	720	1283	2330	2330	3254	3254	3254	3254	3200
LAKEWOOD	0	738	747	1225	1480	1480	2204	2204	2211	2211	2211
NORTH OLMSTED	0	0	0	0	0	0	0	0	0	0	0
ROCKY RIVER	0	29	201	258	946	946	1604	1604	1613	1613	1613
WILLOUGHBY-EASTLAKE	0	139	749	1136	1612	1612	2177	2177	2230	2230	2230
EASTERLY	0	2488	2592	6290	7599	7599	15288	15288	15288	15288	15288
SOUTHERLY	200	7090	8816	15592	18285	18285	26765	26765	26765	26765	26765
WESTERLY	0	3080	3080	3080	4562	4562	4562	4562	4562	4562	4562
WESTERN LAND TREATMENT	0	0	0	0	0	0	0	0	0	0	0
INTERIM PLANTS	2	1080	1080	1080	1080	1080	1080	1080	2	2	2
STRIP-MINE PIPELINE	0	65	94	94	1627	1627	1773	1773	1956	1956	1956
TOTAL AT 5 3/8%	232	18477	21186	38152	50095	50095	66632	66632	66243	66243	66199
TOTAL AT 7 %	290	22287	25614	45746	60214	60214	80130	80130	79680	79680	79626
TOTAL AT 10 %	411	30158	34773	61377	81058	81058	107973	107973	107385	107385	107309

TA '-10 (Continued)

PLAN A

ANNUAL OPERATION AND MAINTENANCE COSTS IN $1000

PLANT	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL
RANDOLPH	32	57	66	91	119	133	148	164	182	193	205	6157
NEW KENT	487	712	915	1137	1360	1537	1714	1903	2092	2250	2408	73652
BURTON	27	56	71	99	131	146	162	180	199	220	242	6790
MANTUA	45	68	78	104	133	147	162	179	197	209	223	6841
BUTTERNUT CREEK	37	66	82	108	138	157	176	199	223	253	286	7600
CHARDON	0	0	1	1	1	1	1	1	1	1	2	40
EAST CLARIDON	12	19	24	35	50	61	74	82	93	103	114	2914
TROY TOWNSHIP	14	20	24	36	49	57	68	77	89	98	109	2800
AUBURN TOWNSHIP	25	50	61	86	115	133	152	169	187	203	220	6196
SHALERSBERG	0	0	0	0	0	0	0	0	0	0	0	0
RAVENNA	210	284	351	477	615	791	967	1083	1200	1297	1396	38591
AURORA CENTRAL	32	77	119	190	272	306	340	393	446	510	575	14475
FAIRMOUNT ROAD	9	62	103	197	303	349	397	455	514	569	627	16037
FOWLER'S MILL	65	108	132	166	202	225	249	288	329	376	425	11295
NEWBURY TOWNSHIP	51	82	102	132	169	189	210	233	257	303	350	9115
CHAGRIN FALLS	106	172	225	301	386	423	462	510	560	608	658	19646
CHAGRIN EAST BRANCH	76	120	150	189	231	253	276	308	342	381	423	12148
UPPER EAST BRANCH	0	0	0	0	0	0	0	0	0	0	0	0
HINCKLEY	0	0	0	0	0	0	0	0	0	0	0	0
MEDINA COUNTY	0	0	0	0	0	0	0	0	0	0	0	0
NEW MEDINA	0	0	0	0	0	0	0	0	0	0	0	0
MALLET CREEK	0	0	0	0	0	0	0	0	0	0	0	0
LIVERPOOL	297	576	782	990	1202	1370	1540	1756	1974	2226	2479	67487
MIDDLEFIELD	109	160	194	241	292	315	339	386	435	482	531	15385
MC FARLAND CREEK	23	90	129	242	364	421	478	550	625	694	764	19551
AKRON	4687	6158	6681	8343	8796	9401	10007	10800	11595	12520	13446	457685
EUCLID	1146	1535	1744	2107	2210	2418	2628	2859	3090	3261	3432	118255
LAKEWOOD	1388	1725	1771	2022	1972	1972	1972	2023	2075	2126	2178	94682
NORTH OLMSTED	0	0	0	0	0	0	0	0	0	0	0	0
ROCKY RIVER	637	920	1120	1298	1500	1610	1723	1860	1998	2106	2216	75816
WILLOUGHBY-EASTLAKE	264	439	656	939	1391	1594	1798	2026	2256	2450	2646	73478
EASTERLY	8978	9516	10062	11624	13278	13726	14175	14444	14714	15072	15431	623396
SOUTHERLY	7300	8389	9501	12784	16671	17730	18790	19645	20500	20902	21306	775620
WESTERLY	3014	3066	3117	3224	3331	3395	3460	3524	3588	3690	3792	162738
WESTERN LAND TREATMENT	0	0	0	0	0	0	0	0	0	0	0	0
INTERIM PLANTS	1891	2506	1975	2306	2633	0	0	0	0	0	0	49333
STRIP-MINE PIPELINE	0	35	40	45	410	445	480	490	500	510	520	15075
TOTAL	30962	37068	40276	49524	58324	59305	62948	66587	70261	73613	77004	2782798

TOTAL ANNUAL COSTS IN $1000

FOR INTEREST RATE OF 5 3/8 %												
TOTAL ANNUAL CAPITAL	232	18477	21186	38152	50095	50095	66632	66632	66243	66243	66199	
TOTAL ANNUAL O&M	30962	37068	40276	49524	58324	59305	62948	66587	70261	73613	77004	
TOTAL ANNUAL COSTS	31194	55545	61462	87676	108419	109400	129580	133219	136504	139856	143203	
FOR INTEREST RATE OF 7 %												
TOTAL ANNUAL CAPITAL	290	22287	25614	45746	60214	60214	80130	80130	79680	79680	79626	
TOTAL ANNUAL O&M	30962	37068	40276	49524	58324	59305	62948	66587	70261	73613	77004	
TOTAL ANNUAL COSTS	31252	59355	65890	95270	118538	119519	143078	146717	149941	153293	156630	
FOR INTEREST RATE OF 10 %												
TOTAL ANNUAL CAPITAL	411	30158	34773	61377	81058	81058	107973	107973	107385	107385	107309	
TOTAL ANNUAL O&M	30962	37068	40276	49524	58324	59305	62948	66587	70261	73613	77004	
TOTAL ANNUAL COSTS	31373	67226	75049	110901	139382	140363	170921	174560	177646	180998	184313	

TABLE V-11

PLAN B

ANNUAL COSTS OF MUNICIPAL/INDUSTRIAL WASTEWATER TREATMENT

CAPITAL EXPENDITURES IN $1000

PLANT	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL	RESIDUAL
RANDOLPH	8	524	654	18	239	222	220	27	215	426	90	2524	962
NEW KENT	520	12040	0	560	5680	0	7240	0	560	5680	0	32280	6807
BURTON	36	3761	492	0	969	454	888	0	1442	699	364	8531	3178
MANTUA	0	342	643	22	159	228	216	28	219	476	100	2304	978
BUTTERNUT CREEK	12	841	1216	25	306	327	314	40	407	541	140	3981	1480
CHARDON	0	122	229	3	112	112	28	3	28	209	26	851	322
EAST CLARIDON	5	339	338	10	124	189	122	11	149	322	47	1579	764
TROY TOWNSHIP	5	207	383	13	169	182	109	18	153	297	60	1521	618
AUBURN TOWNSHIP	8	315	912	15	267	260	240	29	263	447	99	2721	888
SHALERSBORO	33	564	1894	41	509	436	459	58	491	827	228	5208	1748
RAVENNA	0	3276	5725	191	2477	1834	2067	388	2217	2953	1042	20331	8468
AURORA CENTRAL	30	634	2091	53	1445	546	493	62	644	862	239	6780	2737
FAIRMOUNT ROAD	0	1443	1867	147	1277	620	739	120	834	1088	387	8018	3530
FOWLER'S MILL	20	1478	1086	33	445	457	486	75	593	748	227	5324	1804
NEWBURY TOWNSHIP	15	439	710	18	1032	370	263	24	427	578	135	3842	1349
CHAGRIN FALLS	0	5205	2827	166	1198	981	1844	160	1261	1697	602	15153	4579
CHAGRIN EAST BRANCH	20	1349	1458	23	403	401	422	37	441	726	166	5232	1824
UPPER EAST BRANCH	0	416	772	22	300	197	242	11	283	547	131	2830	808
HINCKLEY	0	3360	1011	50	373	308	318	38	343	706	158	6483	1751
MEDINA COUNTY	0	2149	1643	57	750	872	739	93	913	1158	400	8277	2670
NEW MEDINA	0	6744	0	0	2896	0	1663	0	1976	1376	692	14403	5108
MALLET CREEK	0	435	442	6	159	204	103	16	131	354	58	1827	614
LIVERPOOL	0	3248	1474	51	614	773	671	89	1167	1096	380	9066	2592
MIDDLEFIELD	0	0	0	0	0	0	0	0	0	0	0	0	0
MC FARLAND CREEK	0	0	0	0	0	0	0	0	0	0	0	0	0
AKRON	3244	17502	1200	82555	3600	0	3900	0	38800	0	63126	213927	91681
EUCLID	1110	8100	0	6560	13600	0	13900	0	12400	0	0	55670	15588
LAKEWOOD	750	8775	0	5560	3350	0	11400	0	12250	0	750	42835	13929
NORTH OLMSTED	0	0	0	0	0	0	0	0	0	0	0	0	0
ROCKY RIVER	400	115	2010	670	9200	0	8550	1050	685	960	400	24040	8050
WILLOUGHBY-EASTLAKE	0	1850	7906	4500	6434	0	7375	1400	6480	4150	0	40095	13910
EASTERLY	0	30500	1458	43000	17000	0	115353	0	58000	0	0	265311	85115
SOUTHERLY	2780	90765	23975	88000	34986	0	110130	0	71000	0	88000	509636	201760
WESTERLY	0	40000	0	0	19247	0	0	0	40000	0	0	99247	28571
WESTERN LAND TREATMENT	0	0	0	0	0	0	0	0	0	0	0	0	0
INTERIM PLANTS	0	12951	0	0	0	0	0	0	0	0	0	12951	0
STRIP-MINE PIPELINE	0	900	400	21000	0	0	2000	0	2500	0	900	27700	10010
TOTAL	8996	260689	64816	253369	129320	9973	292494	3777	257272	28923	158947	1460478	524193

TABLE V-11 (Continued)

PLAN B

ANNUAL CAPITAL COSTS IN $1000 (AT 7%)

PLANT	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
RANDOLPH	0	17	39	91	108	125	138	140	148	150	150
NEW KENT	37	1005	1005	1053	1542	1542	1542	1542	1542	1542	1542
BURTON	2	76	321	321	381	415	491	466	542	521	562
MANTUA	0	1	25	78	87	105	117	119	127	134	134
BUTTERNUT CREEK	0	37	96	156	178	202	222	225	246	256	256
CHARDON	0	0	9	27	35	43	44	44	45	46	46
EAST CLARIDON	0	10	25	52	61	75	83	84	89	94	94
TROY TOWNSHIP	0	1	15	46	59	72	79	80	86	91	91
AUBURN TOWNSHIP	0	2	48	95	113	133	148	150	161	168	168
SHALERSBORO	2	5	84	194	229	261	286	290	308	320	320
RAVENNA	0	115	241	709	895	1032	1131	1160	1245	1290	1289
AURORA CENTRAL	2	6	118	211	314	355	386	390	421	435	435
FAIRMOUNT ROAD	0	56	106	257	355	402	445	454	492	510	509
FOWLER'S MILL	1	75	109	198	228	263	293	298	328	341	341
NEWBURY TOWNSHIP	1	3	33	91	165	192	207	209	231	242	242
CHAGRIN FALLS	0	286	403	612	699	773	887	899	949	975	975
CHAGRIN EAST BRANCH	1	63	139	214	241	271	297	299	318	329	329
UPPER EAST BRANCH	0	2	31	95	114	129	141	142	152	160	160
HINCKLEY	0	206	243	326	352	375	392	395	407	417	417
MEDINA COUNTY	0	101	157	292	344	410	454	461	509	532	532
NEW MEDINA	0	111	508	508	703	703	849	795	902	855	934
MALLET CREEK	0	14	32	67	78	93	99	100	104	109	109
LIVERPOOL	0	180	236	358	399	457	497	504	571	594	594
MIDDLEFIELD	0	0	0	0	0	0	0	0	0	0	0
MC FARLAND CREEK	0	0	0	0	0	0	0	0	0	0	0
AKRON	8	1538	1667	8220	8479	8479	8779	8779	8779	8779	8779
EUCLID	25	698	720	1283	2330	2330	3254	3254	3254	3254	3200
LAKEWOOD	0	738	747	1225	1480	1480	2204	2204	2211	2211	2211
NORTH OLMSTED	0	0	0	0	0	0	0	0	0	0	0
ROCKY RIVER	0	29	201	258	946	946	1604	1604	1613	1613	1613
WILLOUGHBY-EASTLAKE	0	139	749	1136	1612	1612	2177	2177	2230	2230	2230
EASTERLY	0	2488	2592	6290	7599	7599	15288	15288	15288	15288	15288
SOUTHERLY	200	7090	8816	15592	18206	18206	26686	26686	26686	26686	26686
WESTERLY	0	3080	3080	3080	4562	4562	4562	4562	4562	4562	4562
WESTERN LAND TREATMENT	0	0	0	0	0	0	0	0	0	0	0
INTERIM PLANTS	0	997	997	997	997	997	997	997	0	0	0
STRIP-MINE PIPELINE	0	65	94	94	1627	1627	1773	1773	1956	1956	1956
TOTAL AT 5 3/8%	223	15953	19590	36879	46186	46803	63666	63674	63623	63769	63831
TOTAL AT 7 %	279	19234	23686	44226	55518	56266	76552	76570	76502	76690	76754
TOTAL AT 10 %	394	26008	32150	59360	74725	75743	103132	103172	103062	103347	103408

TAB -11 (Continued)

PLAN B

ANNUAL OPERATION AND MAINTENANCE COSTS IN $1000

PLANT	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL
RANDOLPH	32	41	15	28	35	37	45	45	51	51	52	1761
NEW KENT	487	712	915	1137	1360	1537	1714	1903	2092	2250	2408	73652
BURTON	136	172	94	113	141	132	147	158	171	177	178	6613
MANTUA	45	50	14	30	34	37	42	44	48	49	51	1780
BUTTERNUT CREEK	37	48	19	38	45	47	59	61	68	70	74	2322
CHARDON	0	0	5	13	13	14	17	17	18	19	19	616
EAST CLARIDON	12	15	8	17	21	22	28	29	31	31	34	1061
TROY TOWNSHIP	14	18	8	17	23	23	28	29	34	34	35	1119
AUBURN TOWNSHIP	25	32	18	32	39	51	57	58	62	64	67	2101
SHALERSBORO	2	3	33	62	78	95	103	110	116	118	118	3657
RAVENNA	210	285	102	240	304	341	441	467	507	524	522	16367
AURORA CENTRAL	32	60	29	65	82	89	112	120	131	139	143	4222
FAIRMOUNT ROAD	9	43	29	77	107	116	144	157	165	172	175	5144
FOWLER'S MILL	65	86	24	53	63	77	87	92	101	107	110	3505
NEWBURY TOWNSHIP	51	64	19	37	51	53	67	73	80	84	85	2683
CHAGRIN FALLS	129	212	96	175	224	236	263	274	289	299	299	10460
CHAGRIN EAST BRANCH	76	97	30	55	69	72	90	93	100	104	108	3641
UPPER EAST BRANCH	0	1	16	37	45	51	53	57	61	61	63	1961
HINCKLEY	0	15	35	62	77	86	94	98	103	104	105	3447
MEDINA COUNTY	53	116	45	90	106	134	157	165	187	205	219	6185
NEW MEDINA	161	215	195	219	276	309	331	357	386	396	398	13753
MALLET CREEK	13	19	11	24	28	35	37	38	42	43	44	1447
LIVERPOOL	53	122	51	96	113	139	158	172	197	216	220	6454
MIDDLEFIELD	0	0	0	0	0	0	0	0	0	0	0	0
MC FARLANE CREEK	0	0	0	0	0	0	0	0	0	0	0	0
AKRON	4687	6158	6681	8343	8796	9401	10007	10800	11595	12520	13446	457685
EUCLID	1146	1535	1744	2107	2210	2418	2628	2859	3090	3261	3432	118255
LAKEWOOD	1388	1725	1771	2022	1972	1972	1972	2023	2075	2126	2178	94682
NORTH OLMSTED	0	0	0	0	0	0	0	0	0	0	0	0
ROCKY RIVER	637	920	1120	1298	1500	1610	1723	1860	1998	2106	2216	75816
WILLOUGHBY-EASTLAKE	264	439	656	939	1391	1594	1798	2026	2256	2450	2646	73478
EASTERLY	8978	9516	10062	11624	13278	13726	14175	14444	14714	15072	15431	623396
SOUTHERLY	7300	8357	9435	12642	16410	17441	18472	19295	20118	20492	20867	763392
WESTERLY	3014	3066	3117	3224	3331	3395	3460	3524	3588	3690	3792	162738
WESTERN LAND TREATMENT	0	0	0	0	0	0	0	0	0	0	0	0
INTERIM PLANTS	1869	2443	1975	2306	2633	0	0	0	0	0	0	48830
STRIP-MINE PIPELINE	0	35	40	45	410	445	480	490	500	510	520	15075
TOTAL	30925	36620	38412	47267	55265	55735	58989	61938	64974	67544	70055	2607298

TOTAL ANNUAL COSTS IN $1000

FOR INTEREST RATE OF 5 3/8 %

TOTAL ANNUAL CAPITAL	223	15953	19590	36879	46186	46803	63666	63674	63623	63769	63831
TOTAL ANNUAL O&M	30925	36620	38412	47267	55265	55735	58989	61938	64974	67544	70055
TOTAL ANNUAL COSTS	31148	52573	58002	84146	101451	102538	122655	125612	128597	131313	133886

FOR INTEREST RATE OF 7 %

TOTAL ANNUAL CAPITAL	279	19234	23686	44226	55518	56266	76552	76570	76502	76690	76754
TOTAL ANNUAL O&M	30925	36620	38412	47267	55265	55735	58989	61938	64974	67544	70055
TOTAL ANNUAL COSTS	31204	55854	62098	91493	110783	112001	135541	138508	141476	144234	146809

FOR INTEREST RATE OF 10 %

TOTAL ANNUAL CAPITAL	394	26008	32150	59360	74725	75743	103132	103172	103062	103347	103408
TOTAL ANNUAL O&M	30925	36620	38412	47267	55265	55735	58989	61938	64974	67544	70055
TOTAL ANNUAL COSTS	31319	62628	70562	106627	129990	131478	162121	165110	168036	170891	173463

TABLE V-12

PLAN C

ANNUAL COSTS OF MUNICIPAL/INDUSTRIAL WASTEWATER TREATMENT

CAPITAL EXPENDITURES IN $1000

PLANT	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL	RESIDUAL
RANDOLPH	8	524	654	18	239	222	220	27	215	426	90	2524	962
NEW KENT	520	8627	15891	451	4553	2965	4776	841	4933	7073	2792	48633	19373
BURTON	36	3761	492	0	969	454	888	0	1442	699	364	8531	3178
MANTUA	0	342	643	22	159	228	216	28	219	476	100	2304	978
BUTTERNUT CREEK	12	841	1216	25	306	327	314	40	407	541	140	3981	1480
CHARDON	0	122	229	3	112	112	28	3	28	209	26	851	322
EAST CLARIDON	5	339	338	10	124	189	122	11	149	322	47	1579	764
TROY TOWNSHIP	5	207	383	13	169	182	109	18	153	297	60	1521	618
AUBURN TOWNSHIP	8	315	912	15	267	260	240	29	263	447	99	2721	888
SHALERSBORO	33	564	1894	41	509	436	459	58	491	827	228	5208	1748
RAVENNA	0	3276	5725	191	2477	1834	2067	388	2217	2953	1042	20331	8468
AURORA CENTRAL	30	634	2091	53	1445	546	493	62	644	862	239	6780	2737
FAIRMOUNT ROAD	0	1443	1867	147	1277	620	739	120	834	1088	387	8018	3530
FOWLER'S MILL	20	1478	1086	33	445	457	486	75	593	748	227	5324	1804
NEWBURY TOWNSHIP	15	439	710	18	1032	370	263	24	427	578	135	3842	1349
CHAGRIN FALLS	0	5205	2827	166	1198	981	1844	160	1261	1697	602	15153	4579
CHAGRIN EAST BRANCH	20	1349	1458	23	403	401	422	37	441	726	166	5232	1824
UPPER EAST BRANCH	0	416	772	22	300	197	242	11	283	547	131	2830	808
HINCKLEY	0	3360	1011	50	373	308	318	38	343	706	158	6483	1751
MEDINA COUNTY	0	2149	1643	57	750	872	739	93	913	1158	400	8277	2670
NEW MEDINA	0	6744	0	0	2896	0	1663	0	1976	1376	692	14403	5108
MALLET CREEK	0	435	442	6	159	204	103	16	131	354	58	1827	614
LIVERPOOL	0	3248	1474	51	614	773	671	89	1167	1096	380	9056	2592
MIDDLEFIELD	0	0	0	0	0	0	0	0	0	0	0	0	0
MC FARLAND CREEK	0	0	0	0	0	0	0	0	0	0	0	0	0
AKRON	118	26108	3900	82000	5800	0	6600	0	41600	9200	62700	238026	103205
EUCLID	1110	8100	0	60	0	0	0	0	0	0	0	9270	0
LAKEWOOD	750	8775	0	60	0	0	0	0	0	0	0	9585	0
NORTH OLMSTED	754	3720	12641	72	80	0	0	0	0	0	0	17267	1439
ROCKY RIVER	400	115	2010	110	0	0	0	0	0	0	0	2635	0
WILLOUGHBY-EASTLAKE	350	1975	6506	40	2184	0	0	0	0	0	0	11055	1404
EASTERLY	0	28000	1458	0	0	0	0	0	0	0	0	29458	291
SOUTHERLY	1000	90765	23975	0	15986	0	0	0	0	0	0	131726	13164
WESTERLY	0	40000	0	0	0	0	0	0	0	0	0	40000	0
WESTERN LAND TREATMENT	0	48884	532331	0	90410	7528	35028	6458	15663	4852	79031	820185	317200
INTERIM PLANTS	0	11252	0	0	0	0	0	0	0	0	0	11252	0
STRIP-MINE PIPELINE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	5194	313512	626579	83757	135236	20466	59050	8626	76793	39258	150294	1505878	504848

TABLE V-12 (Continued)

PLAN C

ANNUAL CAPITAL COSTS IN $1000 (AT 7%)

PLANT	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
RANDOLPH	0	17	39	91	108	125	138	140	148	150	150
NEW KENT	37	396	671	1974	2268	2490	2740	2802	2993	3053	3052
BURTON	2	76	321	321	381	415	492	466	542	514	555
MANTUA	0	1	25	78	88	105	117	119	127	130	130
BUTTERNUT CREEK	0	37	96	156	178	203	222	225	246	251	251
CHARDON	0	0	9	27	35	43	44	44	45	46	46
EAST CLARIDON	0	10	25	52	61	75	83	84	90	92	92
TROY TOWNSHIP	0	1	15	46	59	72	79	80	86	88	88
AUBURN TOWNSHIP	0	2	48	95	114	133	148	150	161	164	164
SHALERSBORO	2	5	84	194	229	262	286	290	309	314	314
RAVENNA	0	115	241	710	895	1032	1132	1160	1245	1274	1273
AURORA CENTRAL	2	6	119	211	314	355	386	390	421	429	429
FAIRMOUNT ROAD	0	56	106	258	355	402	446	455	492	503	502
FOWLER'S MILL	1	75	109	198	229	263	293	299	328	336	335
NEWBURY TOWNSHIP	1	3	34	91	165	193	208	209	231	237	236
CHAGRIN FALLS	0	286	403	613	700	773	888	900	949	964	963
CHAGRIN EAST BRANCH	1	63	139	214	241	272	297	299	318	323	323
UPPER EAST BRANCH	0	2	31	95	114	129	141	142	152	155	155
HINCKLEY	0	206	243	326	352	375	392	395	407	411	411
MEDINA COUNTY	0	101	157	292	345	410	454	461	509	525	524
NEW MEDINA	0	111	509	509	704	704	850	795	903	841	920
MALLET CREEK	0	14	32	67	78	93	99	100	104	106	106
LIVERPOOL	0	180	236	358	400	458	498	504	571	587	586
MIDDLEFIELD	0	0	0	0	0	0	0	0	0	0	0
MC FARLAND CREEK	0	0	0	0	0	0	0	0	0	0	0
AKRON	8	1999	2288	8800	9224	9224	9727	9727	9937	9937	9937
EUCLID	25	699	722	726	726	726	563	563	109	52	30
LAKEWOOD	0	740	749	754	754	754	582	582	70	13	4
NORTH OLMSTED	0	302	1279	1285	1291	1291	1291	1291	1044	564	525
ROCKY RIVER	0	30	202	211	211	211	211	120	120	16	8
WILLOUGHBY-EASTLAKE	0	165	664	667	824	824	824	824	728	382	373
EASTERLY	0	2295	2400	2400	2400	2400	1067	1067	104	104	104
SOUTHERLY	72	6962	8688	8688	9839	9839	9839	9839	4372	4372	4372
WESTERLY	0	3080	3080	3080	3080	3080	3080	3080	0	0	0
WESTERN LAND TREATMENT	0	0	3519	42601	49676	49731	52115	52594	53501	53861	53861
INTERIM PLANTS	0	866	866	866	866	866	866	866	0	0	0
STRIP-MINE PIPELINE	0	0	0	0	0	0	0	0	0	0	0
TOTAL AT 5 3/8%	120	15670	23186	63140	71634	72418	74240	74614	66545	66060	66090
TOTAL AT 7 %	151	18901	28149	77054	87304	88328	90598	91062	81362	80794	80819
TOTAL AT 10 %	215	25595	38428	105768	119634	121161	124365	125037	111932	111196	111214

T V-12 (Continued)

PLAN C

ANNUAL OPERATION AND MAINTENANCE COSTS IN $1000

PLANT	1972	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	TOTAL
RANDOLPH	32	41	15	28	35	37	45	45	51	51	52	1761
NEW KENT	487	713	275	682	778	903	980	1057	1143	1193	1191	39395
BURTON	136	172	94	113	141	132	147	158	171	177	178	6613
MANTUA	45	50	14	30	34	37	42	44	48	49	51	1780
BUTTERNUT CREEK	37	48	19	38	45	47	59	61	68	70	74	2322
CHARDON	0	0	5	13	13	14	17	17	18	19	19	616
EAST CLARIDON	12	15	8	17	21	22	28	29	31	31	34	1061
TROY TOWNSHIP	14	18	8	17	23	23	28	29	34	34	35	1119
AUBURN TOWNSHIP	25	32	18	32	39	51	57	58	62	64	67	2101
SHALERSBORO	2	3	33	62	78	95	103	110	116	118	118	3657
RAVENNA	210	285	102	240	304	341	441	467	507	524	522	16367
AURORA CENTRAL	32	60	29	65	82	89	112	120	131	139	143	4222
FAIRMOUNT ROAD	9	43	29	77	107	116	144	157	165	172	175	5144
FOWLER'S MILL	65	86	24	53	63	77	87	92	101	107	110	3505
NEWBURY TOWNSHIP	51	64	19	37	51	53	67	73	80	84	85	2683
CHAGRIN FALLS	129	212	96	175	224	236	263	274	289	299	299	10460
CHAGRIN EAST BRANCH	76	97	30	55	69	72	90	93	100	104	108	3641
UPPER EAST BRANCH	0	1	16	37	45	51	53	57	61	61	63	1961
HINCKLEY	0	15	35	62	77	86	94	98	103	104	105	3447
MEDINA COUNTY	53	18	45	90	106	134	157	165	187	205	219	5876
NEW MEDINA	161	215	195	219	276	309	331	357	386	396	398	13753
MALLET CREEK	13	19	11	24	28	35	37	38	42	43	44	1447
LIVERPOOL	53	122	51	96	113	139	158	172	197	216	220	6454
MIDDLEFIELD	0	0	0	0	0	0	0	0	0	0	0	0
MC FARLANE CREEK	0	0	0	0	0	0	0	0	0	0	0	0
AKRON	4687	5520	6058	7643	9421	10076	10732	11588	12445	13420	14396	469200
EUCLID	1146	1535	1744	1033	44	48	52	57	62	65	68	27581
LAKEWOOD	1388	1725	1771	1084	35	35	35	35	36	37	38	27797
NORTH OLMSTED	377	1046	1673	1193	80	84	89	93	97	99	101	25482
ROCKY RIVER	637	920	1120	731	26	28	31	33	36	38	40	17478
WILLOUGHBY-EASTLAKE	264	536	770	523	46	49	52	55	59	62	65	12596
EASTERLY	8978	9536	10062	5430	5581	5769	237	241	246	252	258	198584
SOUTHERLY	7300	7995	8710	5356	6121	6465	548	559	570	574	578	194639
WESTERLY	3014	3066	3117	1177	1216	1239	75	76	78	80	82	55213
WESTERN LAND TREATMENT	0	0	244	13041	20450	21738	23006	23746	24458	24975	24512	748793
INTERIM PLANTS	1390	1804	1176	1372	1564	782	0	0	0	0	0	35754
STRIP-MINE PIPELINE	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	30823	36012	37616	40845	47336	49412	38397	40254	42178	43862	44448	1952502

TOTAL ANNUAL COSTS IN $1000

FOR INTEREST RATE OF 5 3/8 %

TOTAL ANNUAL CAPITAL	120	15670	23186	63140	71634	72418	74240	74614	66545	66060	66090
TOTAL ANNUAL O&M	30823	36012	37616	40845	47336	49412	38397	40254	42178	43862	44448
TOTAL ANNUAL COSTS	30943	51682	60802	103985	118970	121830	112637	114868	108723	109922	110538

FOR INTEREST RATE OF 7 %

TOTAL ANNUAL CAPITAL	151	18901	28149	77054	87304	88328	90598	91062	81362	80794	80819
TOTAL ANNUAL O&M	30823	36012	37616	40845	47336	49412	38397	40254	42178	43862	44448
TOTAL ANNUAL COSTS	30974	54913	65765	117899	134640	137740	128995	131316	123540	124656	125267

FOR INTEREST RATE OF 10 %

TOTAL ANNUAL CAPITAL	215	25595	38428	105768	119634	121161	124365	125037	111932	111196	111214
TOTAL ANNUAL O&M	30823	36012	37616	40845	47336	49412	38397	40254	42178	43862	44448
TOTAL ANNUAL COSTS	31038	61607	76044	146613	166970	170573	162762	165291	154110	155058	155662

COMPARATIVE COSTS

Analyses of the annual costs of Plans A, B and C are represented on Figures V-1 through V-7 in terms of the unit cost for each 1,000 gallons treated.

The unit costs include capital investment at 7 per cent interest and all operation and maintenance costs. The unit costs do not include the contingency allowances.

Municipal/Industrial Wastewater

Represented in Figure V-1 are all costs for in-basin and western Ohio treatment sites for all three plans. The time phased average daily flow is plotted against unit cost of treatment. The cost bulge for Plan C reflects the surcharging of capital investment and associated operation and maintenance costs necessary to meet Level 1 treatment standards prior to 1983 with water-based treatment facilities. The amortization period for Level 1 treatment capability for the shoreline plants overlaps with the amortization period for large investments in the tunnel and the western Ohio land treatment site components.

The bulge in Plan C costs illustrates the impact of the constraint to meet Level 1 effluent standards using water-based plants before implementing Level 2 land treatment. The amortization of the Level 1 facilities abandoned in 1985 continues to the period from 1995 to 2000.

The 2010 and 2020 unit costs of treatment are least for Plan C, highest for Plan A, with Plan B falling in between.

The declining costs of all plans after the year 2000 are a result of building capacity prior to need, and of increasing the volumes of wastewater being treated.

Urban Storm Runoff

The time phased average daily flow of urban storm runoff versus unit cost of treatment for each 1,000 gallons is presented in Figure V-2 for all three plans.

The high cost per 1,000 gallons treated, i.e. 3 to 4 times the cost of municipal/industrial wastewater, represents the problems of designing for a peak flow which occurs only once per year, with facilities partially idle the remainder of the time. It should be noted, however, that the costs include collection pipes and a very large amount of flood control storage. Plan C is least costly, Plan A is most costly, and Plan B is intermediate for the full range of years.

Ordinances and other institutional practices to reduce the peak rate of runoff from urban areas could reduce the cost of treating storm runoff by approximately 25 to 40 percent, or more.

There is no cost bulge in Plan C for stormwater as the deep tunnel storage continues to be used through 2020; prior to 1985, only combined stormwater is treated, and that during off-peak capacity of the shoreline plants.

In-Basin Municipal/Industrial Wastewater

Costs of treatment for municipal/industrial wastewater in comparable in-basin facilities for 1990 and 2020 are shown in Figures V-3 and V-4. These cost curves for Plans A and C indicate the economy of scale. In Plan C, the economy of scale is reduced by a relatively high investment in secondary pumping plants and in a force main at Kent. These are required for transmission of the wastewater to the land treatment site which lies south of Kent. The dashed line would indicate the cost trend if the transmission distance were shortened by fifty percent.

The regionalization of the Liverpool plant in Plan A has created unusually high treatment costs, which are out-of-line with the costs of treatment for the other water-based plants in 1990 and 2020.

Kent

Figure V-5 illustrates the impact of time phasing. In Plan A, the Kent facilities are in operation by 1980, but in Plan C by 1985. As a result, the physical-chemical treatment plant system in Plan A has a slightly higher present worth than the Plan C system for Kent.

Burton and Middlefield

For Plan A, the Burton and Middlefield plants are separate; in Plan C, they are combined. The curve in Figure V-6 indicates a significantly lower cost for the land treatment alternative. This advantage has been recognized by residents of the area as indicated by their expressed interest in a land treatment facility.

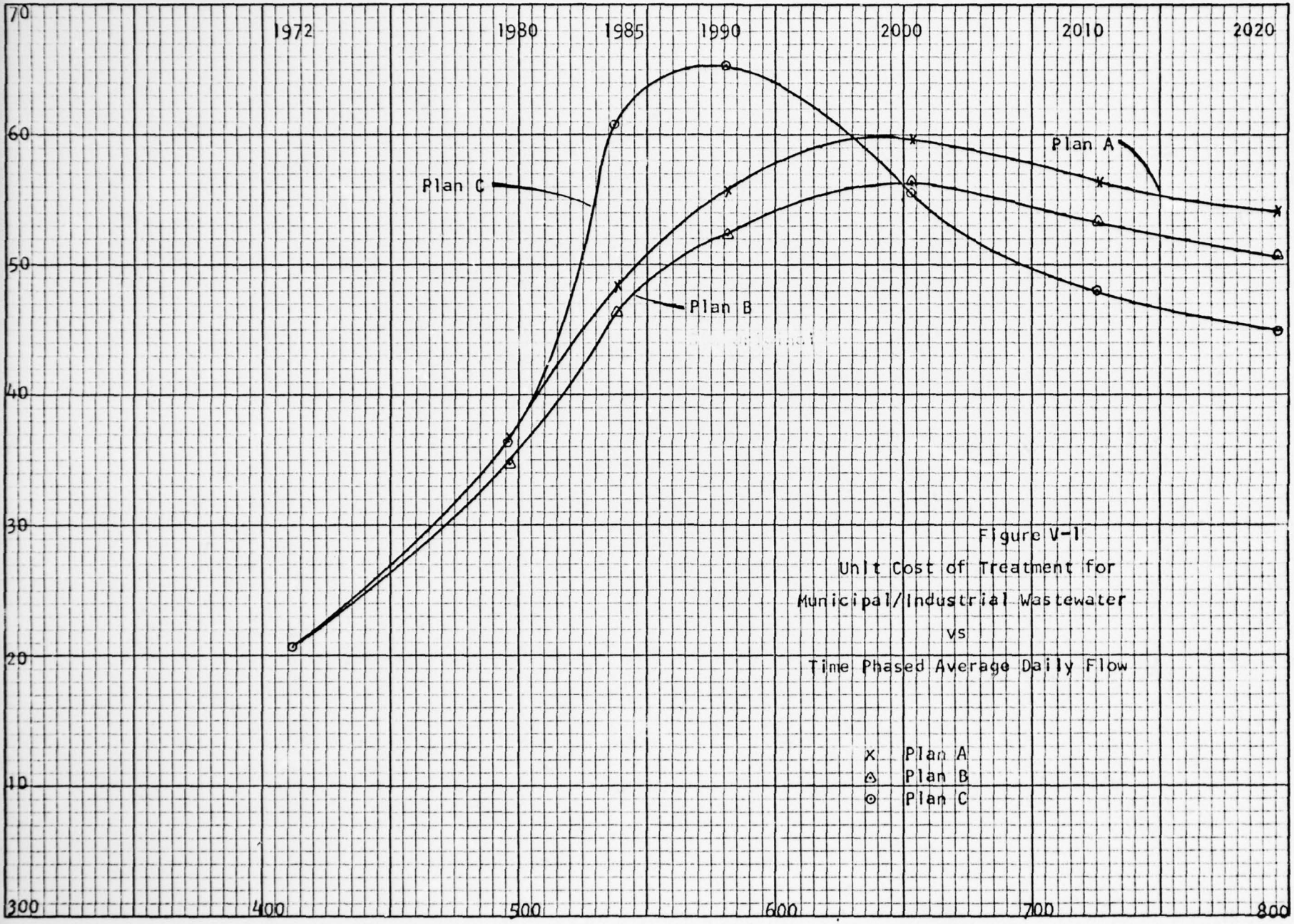
Fairmount Road

Figure V-7 also compares the treatment costs of an advanced biological plant and a land treatment system for Fairmount Roads. The results are similar to those for Burton and Middlefield.

LAND TREATMENT SENSITIVITY

The most important costs variables in land treatment of wastewater are the transmission distance and the application rate. In Figure V-8 the unit cost of land treatment is related to the annual irrigation application rate. This curve shows the total annual costs (without contingencies) of land treatment for the 2020 municipal/industrial sewage flows that are transmitted through the tunnel from the shoreline plants to western Ohio. The costs include such items as sewers and pretreatment at the shoreline plants. Costs for stormwater are not included.

The most sensitive portions of this curve occur in the lower ranges. For example, the cost of treatment doubles for a change in application rate from 40 inches per year to 10 inches per year. Doubling the application rate from 40 inches per year to 80 inches per year results in a savings of about $20 million per year or about 20 percent. A projection of the curve to an application rate of 160 inches, i.e., doubling the rate again, results in a savings of $4 million, which is equivalent to a savings of only 5 percent.



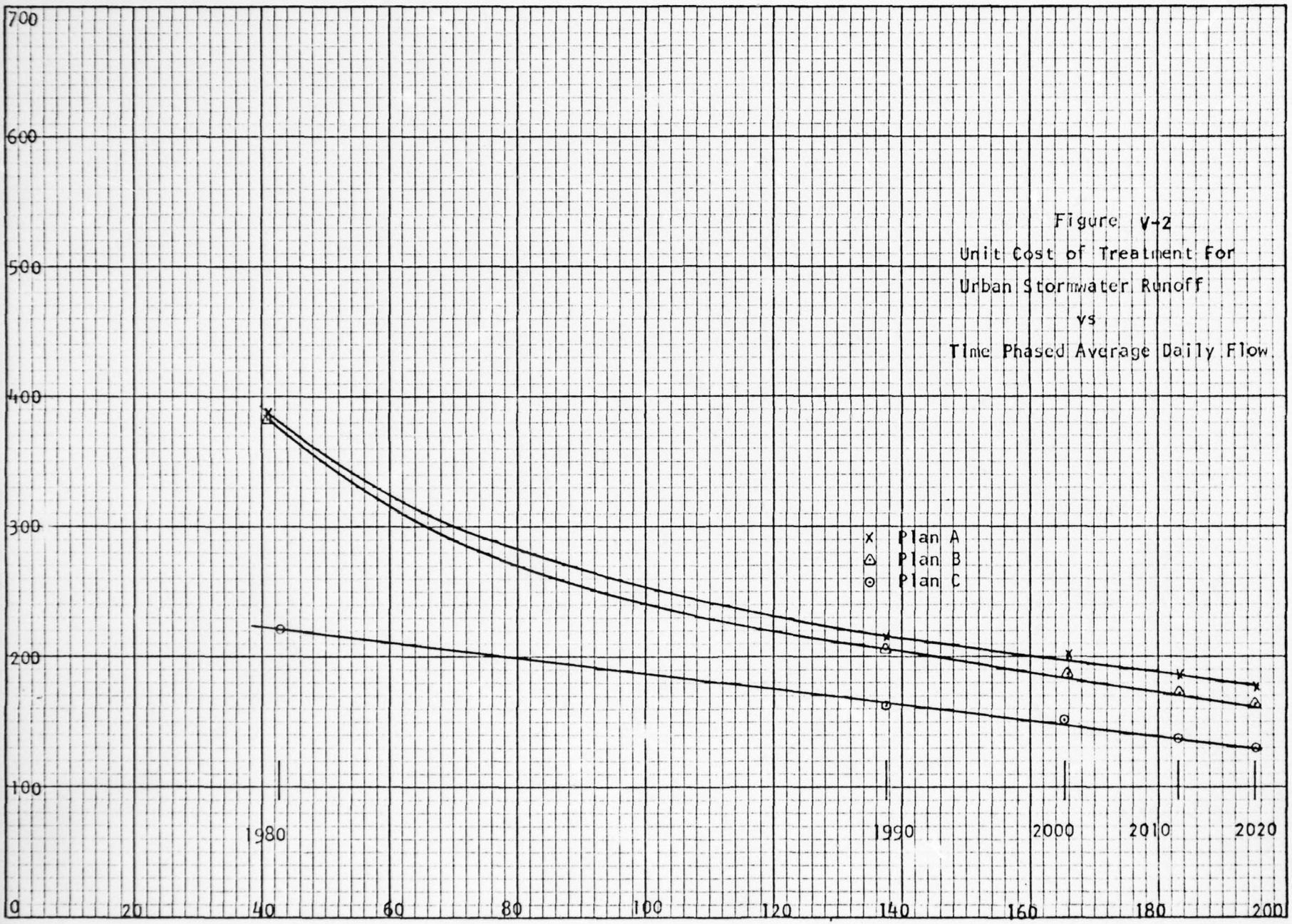


Figure V-2
Unit Cost of Treatment For
Urban Stormwater Runoff
vs
Time Phased Average Daily Flow

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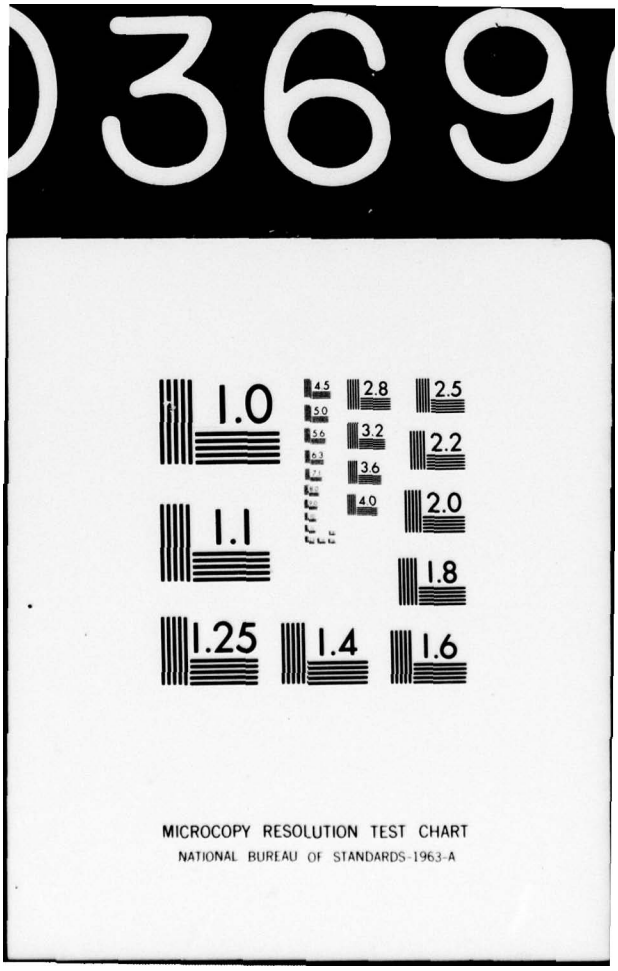
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1.25
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2.0
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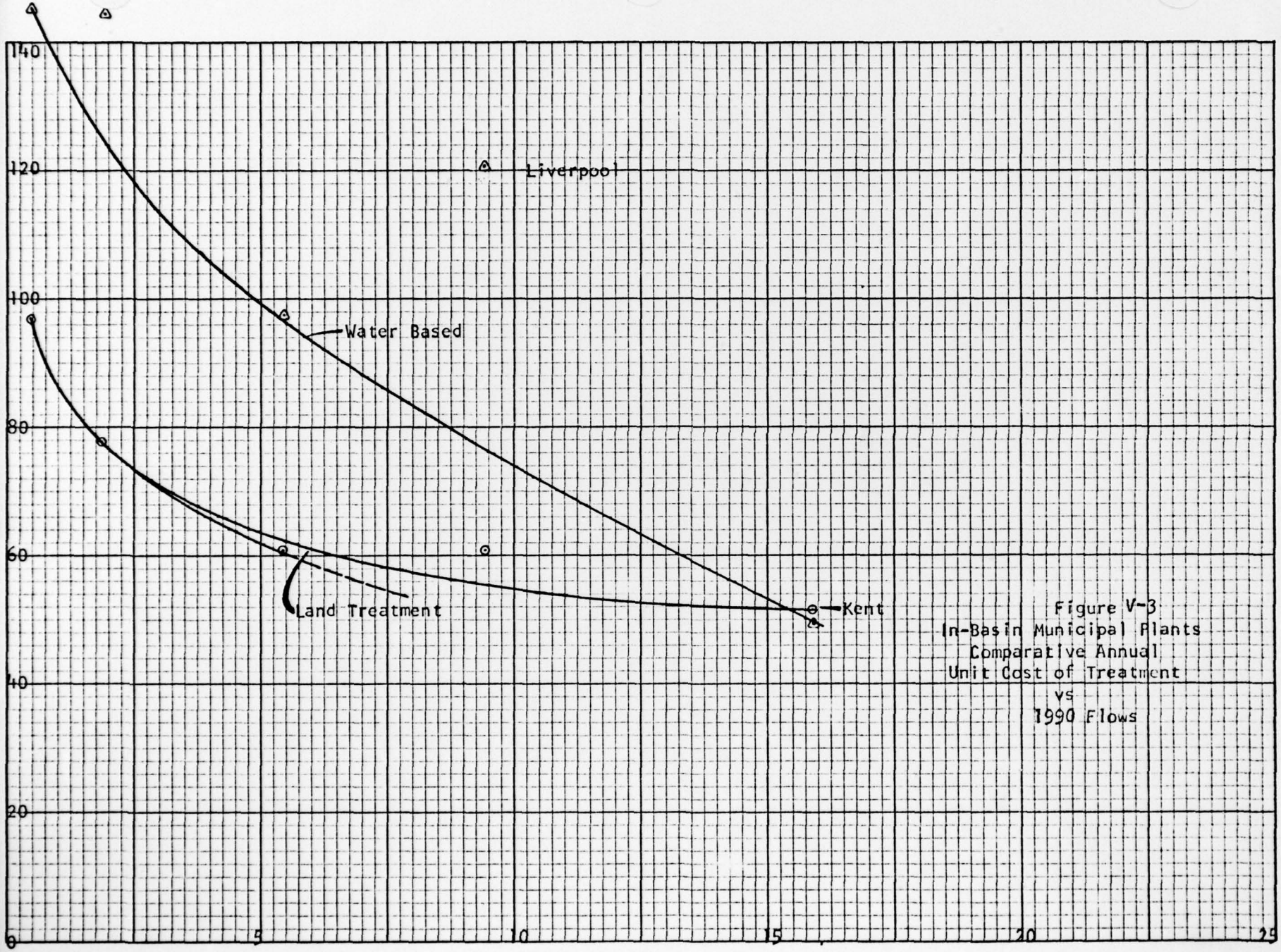

Figure V-3
In-Basin Municipal Plants
Comparative Annual
Unit Cost of Treatment
vs
1990 Flows

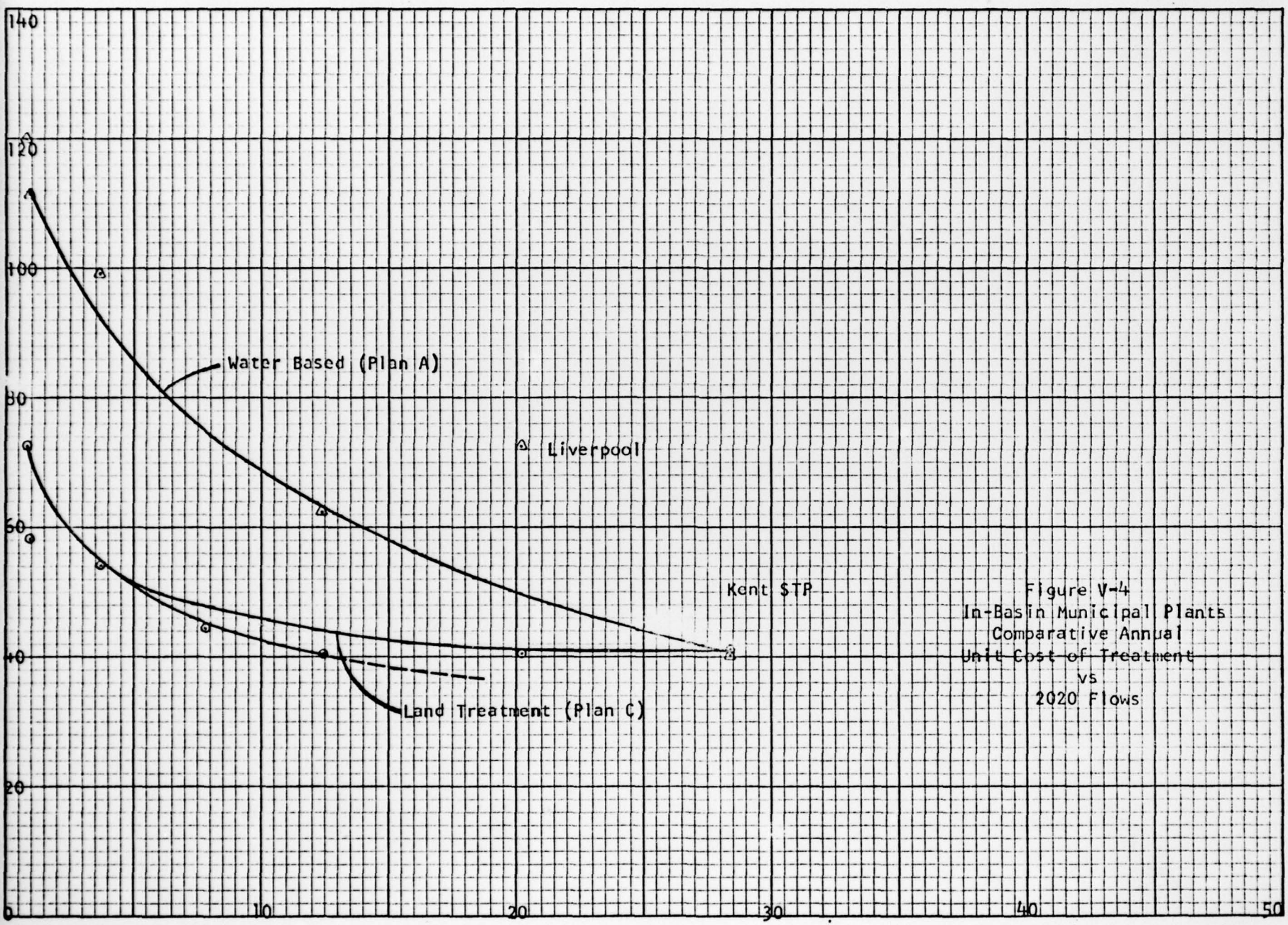

Figure V-4
In-Basin Municipal Plants
Comparative Annual
Unit Cost of Treatment
vs
2020 Flows

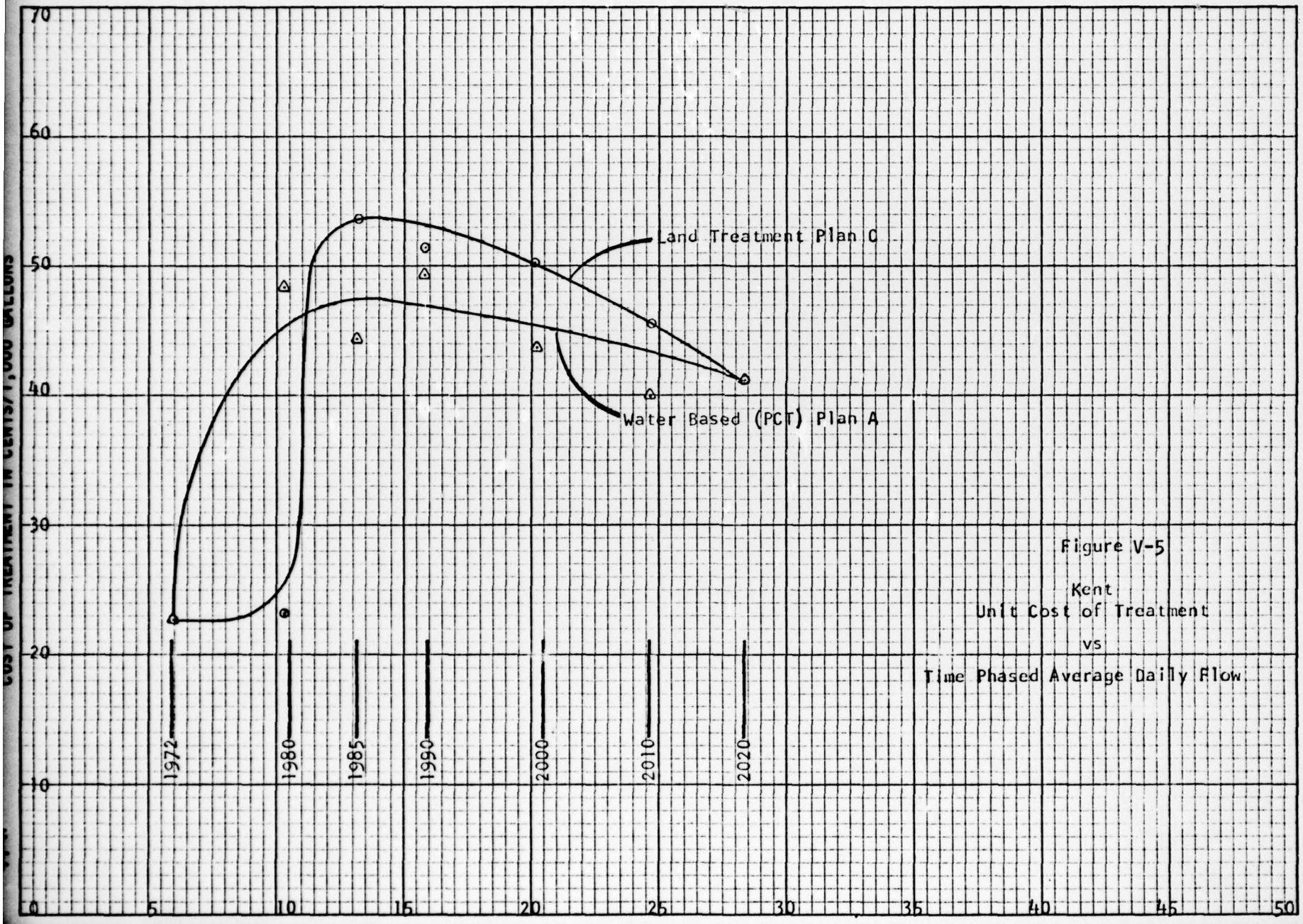

Figure V-5

Kent
Unit Cost of Treatment
vs
Time Phased Average Daily Flow

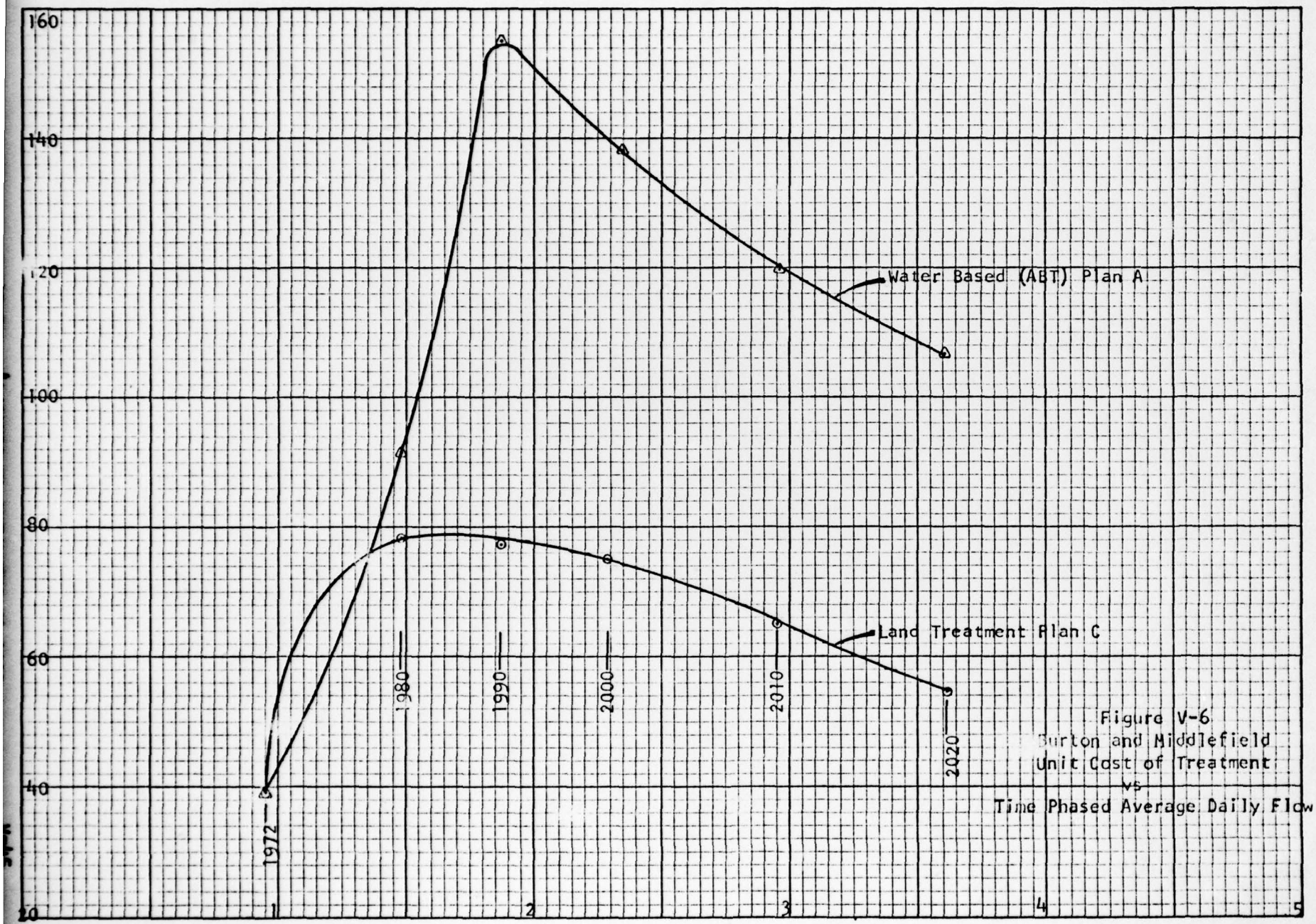

Figure V-6
Burton and Middlefield
Unit Cost of Treatment
vs
Time Phased Average Daily Flow

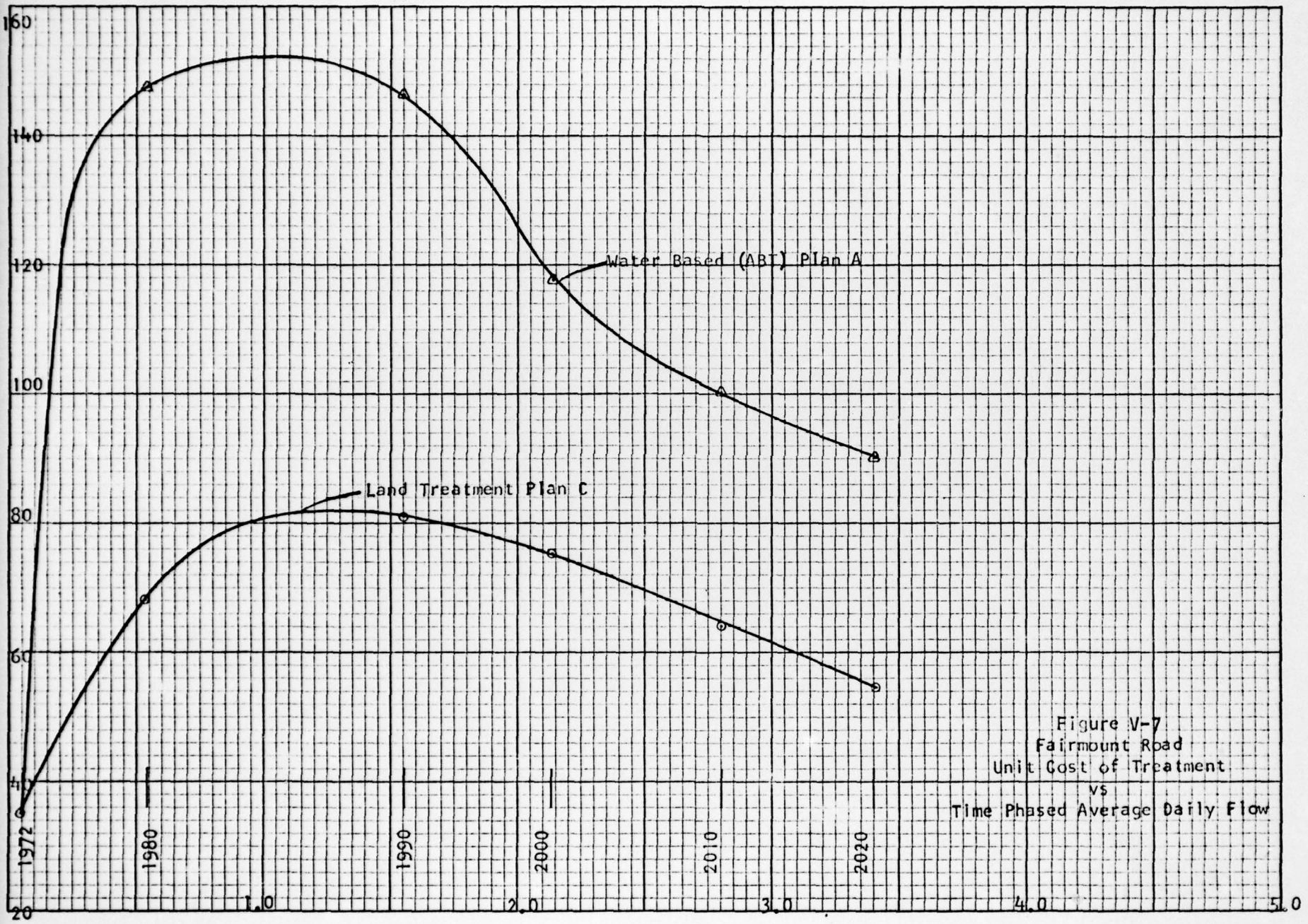

Figure V-7
Fairmount Road
Unit Cost of Treatment
vs
Time Phased Average Daily Flow

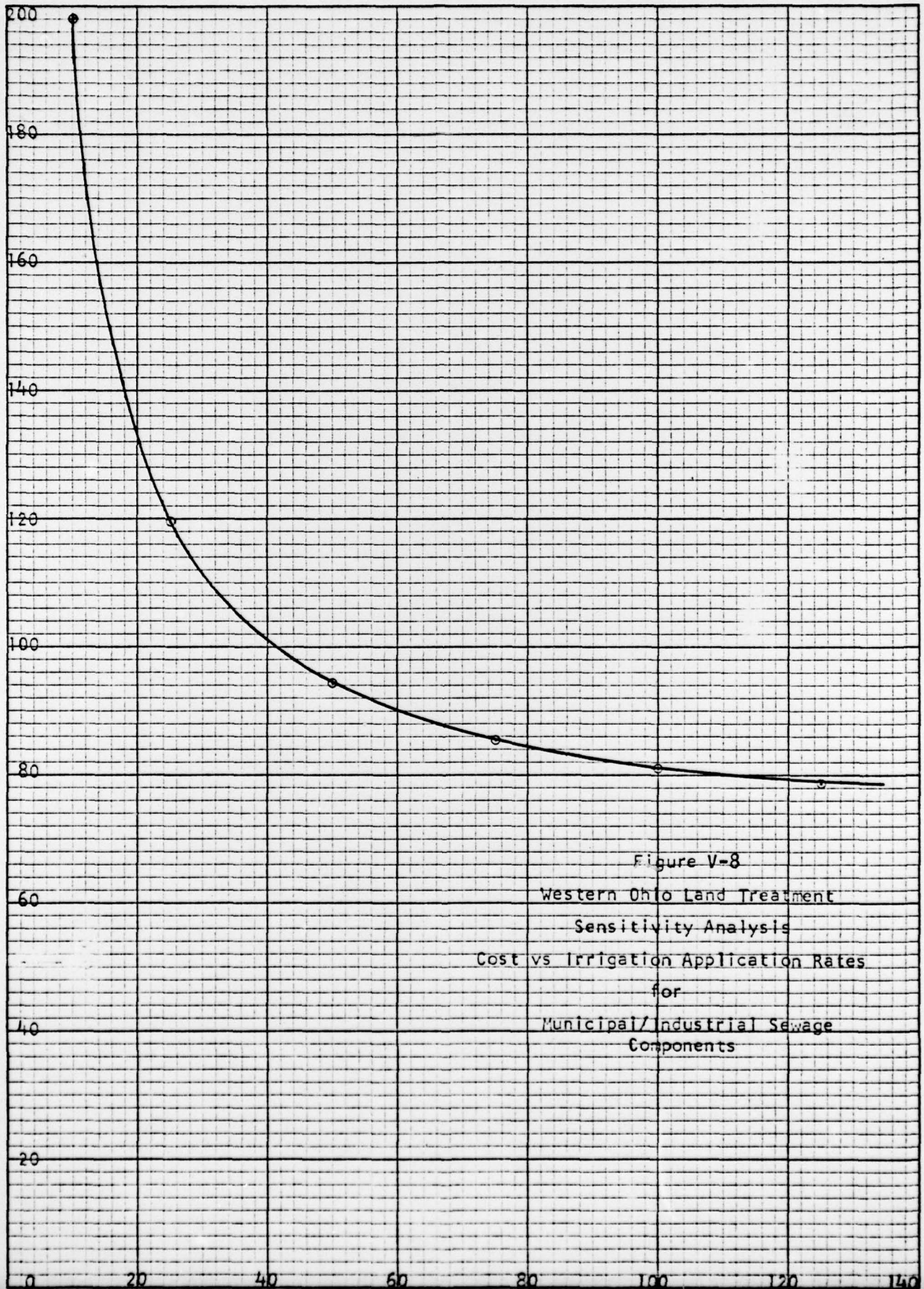

Figure V-8
Western Ohio Land Treatment
Sensitivity Analysis
Cost vs Irrigation Application Rates
for
Municipal/Industrial Sewage
Components

SECONDARY TREATMENT ALTERNATIVE - PLANS B AND C

The 1972 International Agreement on Great Lakes Water Quality between the United States and Canada stipulates that municipal treatment plants with an average daily flow of 1.0 MG or more by 1980 shall have the capability of reducing the phosphorous content in their discharged effluent to one (1) mg/l.

In Plans B and C as now formulated, the municipal facilities in the upper basins provide secondary and tertiary treatment by aerated lagoons and land treatment, respectively. The phosphorous removal in this process is completed by the land treatment. However, a complicating factor arises with respect to the timing: consideration of public acceptance of land treatment may require that it be tested in designated "early-action" sites for several years prior to implementation on a regional basis.* Therefore, it may not be possible to put the land treatment program into operation by the required date for phosphorous removal. It would then be necessary to substitute activated sludge plants with special phosphorous removal components for the aerated lagoons where the average daily flow is greater than one (1) MGD. (For a discussion of the affected plants, see Section IV, Phosphorous Removal Requirements for Plans B and C, pp. IV-24.)

The tabulations shown below indicate the difference in cost which results when the affected secondary treatment plants, which are all designated to precede tertiary land treatment, are altered from aerated lagoons to activated sludge plants. See Table V-13.

* Constraint Imposed on Formulation Contractor for institutional reasons.

TABLE V-13

TOTAL ANNUAL COSTS*

Including Alternate Methods of Secondary Treatment
(at 7 Per Cent Capital Recovery Factor, in $1,000)
For
In-Basin Plants Over 1.0 MGD by 1980

PLAN B

(The affected plants are Liverpool, Medina County, Ravenna and Chagrin Falls)

	1972	1980	1990	2000	2010	2020
With Aerated Lagoons	445	1,331	3,087	3,991	4,454	4,628
With Activated Sludge Plants	445	1,986	4,787	5,286	6,016	6,287

PLAN C

(The affected plants are Liverpool, Medina County, Ravenna, Chagrin Falls and New Kent)

	1972	1980	1990	2000	2010	2020
With Aerated Lagoons	932	2,239	6,095	7,673	8,553	8,884
With Activated Sludge Plants	932	3,443	8,893	9,865	11,036	11,404

*The costs shown do not include phosphate removal with either secondary treatment process.

REUSE AND RECYCLING BENEFITS

Plans A, B and C provide high quality treated wastewater available for many water reuse purposes. The water-based plans A and B, provide conveniently located effluent discharge points in the heavily industrialized and urbanized area of greater Cleveland. Whereas no specific industrial reuses have been evaluated with respect to cost credits, the portion of the Formulation Appendix dealing with the twelve original alternatives presents opportunities which exist.

In Plan C, certain recycling and reuse benefits have been specifically identified and cost estimated. These actual and potential benefits, some of which would be revenue-producing, have not been included in the project cost summary Tables V-1 through V-12. These include the following:

1. Value of crops grown on land treatment sites, at 2020 wastewater loads, in terms of 1972 dollars is estimated at $35,856,000 per year. See Land Treatment Phase III Report, Table III-1.
2. The value of capital contributions from private industry for the power plant site for a 3,000 megawatt capacity plant situated adjacent to the winter reservoir at the Western Land Treatment Area is estimated to be $30,000,000, based on a unit value of $10 per installed kilowatt. Annual income from cooling water sales on an acre-foot basis would be in addition to the capital value.

3. Value of usable nutrient content of study area wastewater for the year 2020 effluent loads is estimated at $9,456,000 annually. This amount is reflected in the value of crops grown given in Item #1 above.

All three plans provide significant flood control benefits because of the temporary storage of urban storm runoff prior to treatment. No flood control benefits have been estimated for any of the plans. On the other hand, significant institutional means of reducing urban storm runoff, such as those implemented in the Chicago area, have generally not been taken into consideration and might be able to reduce substantially the stormwater treatment costs given in this section of the report. This potential cost savings has not been estimated.

SECTION VI

COMPARISONS OF THREE FINAL PLANS

Resource Requirements

If efforts directed towards the abatement of water pollution resulted in a wastewater management system which consumed other natural resources to an inordinate degree, the system might represent a poor balance in the use of available resources in the face of potentially dwindling supplies. Trade-offs must be evaluated among the different rates of use of the various resources by alternative systems. Use of non-recoverable resources might weigh against a plan, particularly if such usage were excessive.

The annual resource requirements for Plans A, B and C are tabulated by decade in Table VI-1.

Chemicals. A comparison of the three formulated plans shows that Plan C, which is primarily land-based, consumes a much lesser quantity of chemicals than Plan A, whose treatment is entirely water-based. It should be noted that for Plan C the tonnage of chemicals required in the year 2020 is almost entirely comprised of the requirements of the Akron Sewage Treatment Plant, which remains water-based. The Phase III Report by Havens and Emerson Ltd. contains a discussion of the particular chemicals involved in the treatment processes and their relative scarcity or abundance.

Electric Power. The land-based treatment in Plan C in the year 2020 utilizes approximately 2.5 times the equivalent electrical energy required by Plan A. The major portion of this increased usage is attributable to the pumping power required to lift the sewage from the tunnel at its western terminus into the aerated lagoons.

TABLE VI-1

ANNUAL RESOURCE REQUIREMENTS

YEAR AND PLAN	CHEMICALS (1000's TONS)			ELECTRIC POWER (1000's MWH)			LAND (1000's ACRES)			MANPOWER (PERSONS)		
	Waste-water	Storm-water	Total	Waste-water	Storm-water	Total	Waste-water	Storm-water	Total	Waste-water	Storm-water	Total
1980												
A	70.4	6.6	77.0	431.6	71.6	503.2	1.3	1.4	2.7	848	699	1,547
B	54.0	6.7	60.7	469.2	70.9	540.1	1.0	1.5	2.5	914	372	1,286
C	65.5	13.4	78.9	479.8	89.8	569.6	4.9	1.8	6.7	947	220	1,167
1990												
A	129.7	32.3	162.0	579.4	90.4	669.8	8.5	4.3	12.8	1,126	1,093	2,219
B	96.7	30.5	127.2	684.9	113.2	798.1	15.8	6.7	22.5	1,229	625	1,854
C	42.5	10.9	53.4	855.0	296.9	1,151.9	122.0	29.3	151.3	755	386	1,141
2000												
A	144.8	38.2	183.0	639.2	119.3	758.5	9.5	4.8	14.3	1,143	1,535	2,678
B	108.7	34.1	142.8	770.8	137.8	908.6	19.3	9.2	28.5	1,241	854	2,095
C	43.2	19.8	63.0	1,610.3	333.6	1,943.9	139.6	35.2	174.8	953	566	1,519
2010												
A	160.9	41.2	202.1	703.1	130.6	833.7	10.6	5.1	15.7	1,163	1,539	2,702
B	121.9	36.7	158.6	855.3	154.7	1,010.0	23.1	10.2	33.3	1,288	866	2,154
C	38.3	20.4	58.7	1,619.8	315.9	1,935.7	154.7	38.5	193.2	1,019	582	1,601
2020												
A	175.7	44.0	219.7	760.0	142.8	902.8	12.4	5.2	17.6	1,180	1,543	2,723
B	133.4	38.5	171.9	940.8	166.6	1,107.4	26.9	11.1	38.0	1,330	875	2,205
C	43.3	21.5	64.8	1,753.4	606.8	2,360.2	169.0	40.8	209.8	1,076	593	1,669

It should be pointed out that the table does not include the additional significant power requirement to produce the chemicals required for the treatment systems. The ratio of the electric power requirements of Plan C to Plan A would be reduced to approximately 2:1 if the electric power required to produce the chemicals were added to the pumping power and other power requirements of the water-based plan. An in-depth analysis of such indirect resource requirements or savings is beyond the scope of this study, even though an awareness of these relationships is quite important to a comparison of land and water-based treatment technologies.

The generation of increasing amounts of electrical energy utilizing fossil fuel could of itself cause yet another form of pollution -- air pollution. The implications of this particular problem are beyond the scope of this study but remain a parameter in any ultimate resource balance.

Plan C does have an important built-in element which would facilitate the generation of additional electric power needed for wastewater treatment on the scale projected in the study. This element is the creation of a large body of cooling water in the Western Land Treatment Area, which could be utilized by a power plant. The adverse ecological effects normally associated with increased water temperatures would not be of concern, and this same body of cooling water would become more efficient in its stabilization of remaining pollutants.

The deep drop shafts utilized in connection with the tunnel, in the land-based treatment Plan C, have a potential for the direct generation of electrical power by means of turbines incorporated in the shaft construction, thereby reducing the amount of electric power required from

sources outside the system.

Land. The use of a much greater amount of land for the land-based system would appear to be a detriment, were it not for the synergistic use of that land. The application of wastewater effluent with its entrained nutrients to the land enhances its agricultural potential. While there is some land which will be required for aerated lagoons and storage reservoirs, the majority of the additional land used in Plan C as compared with Plan A is agricultural land which does not represent a decrease of the total land resource, but an increased resource.

Manpower. The operation of a highly sophisticated technological system is not labor-intensive. The increase in use of manpower from 1980 to 2020 for any of the three formulated plans is not felt to be excessive in view of the large increase in the volumes of water being handled, particularly stormwater. The overall degree of technical competency demanded of the personnel in Plans A and B could require that greater numbers of such personnel be available for the implementation of those plans. Plan C requires less total manpower than Plan A or B.

System Reliability

The matter of reliability of systems has been approached from the standpoint of general consistency from one plan to another. Costing has included allowances for standby facilities, such as parallel process units and standby power supplies. In essence provisions have been made to avoid discharge of inadequately treated wastewater when the overall system is not functioning as intended.

The mean time between failure (MTBF) and the mean time to repair the units (MTTR) have been approached so as to maximize MTBF and minimize MTTR. Standby facilities will tend to minimize the general importance of MTTR in many instances. Selection of good quality equipment, careful treatment plant design, and redundant capacity in storage reservoirs and irrigation piping resulting from peak flow design criteria will further minimize the importance of MTBF for individual items and tend to maximize the MTBF for particular major components, or unit processes.

The land treatment facilities include significant storage capability. During inclement weather or unit failures, water will be stored. The storage capability of advanced waste treatment plants is minimal, and for that reason, parallel units have been incorporated.

This study indicates that the water quality goal of 100 percent reliability is attainable in the systems of the three plans, and this would be one of the final design objectives. The advanced wastewater treatment plants will receive special design control on this aspect because of the lack of effluent storage, which is inherent in the land treatment technology. It has been concluded that all alternative plans are essentially comparable in this respect.

The design performance of all units, components, and systems will be continuously monitored by highly reliable instrumentation. This will include the equivalent of Metropolitan Water Intelligence Systems.